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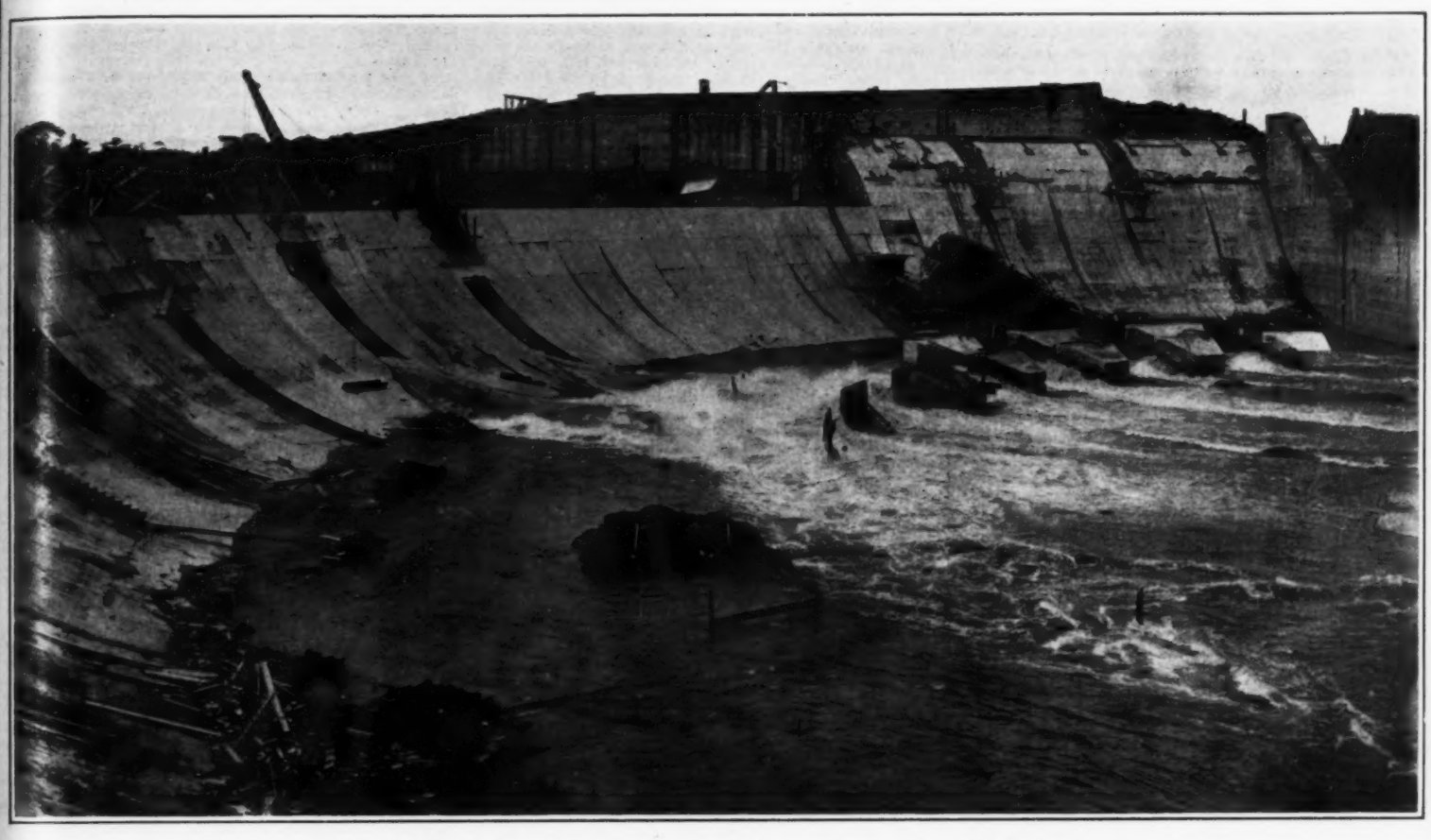


Gatun Spillway—View Looking Southwest, Showing Down Stream Face of Ogee Dam.

Pedro Miguel Locks—Bird's Eye View from Hill on East Bank.

COMPLETING THE PANAMA CANAL.—[See page 328.]

The Incongruities of American Patent Litigation*

A Plea for Adequate Protection of Intellectual Property.

By L. H. Baekeland

WHOEVER was present at the White House Garden Party in honor of the members of the Eighth International Congress of Applied Chemistry must have been impressed by the directness of speech of President Taft. The following is the most striking part of it:

"Patents have played a very great part in the development of the United States, and we have given to patentees a very valuable monopoly for the purpose of discovering by their industries new methods of accomplishing useful results. Whether we have made this monopoly too great or not is the subject of consideration by a commission provided for by Congress.

"There is certainly great room for improvement in the machinery of our Patent Office, and it would be well if more value could inhere in the issuing of a patent as an evidence of real property. Now, however, until a patent has been fought through the courts, people do not seem to regard it as of a great deal of monopoly value.

"I may add that one of the great opportunities for reform, in my judgment, is in the shortening of patent litigation and the reducing of its expenditure. I know very little about chemistry, but I know a good deal about patent litigation. I know the amount of money that has been unnecessarily wasted and the inequality that has been produced between the rich litigant and the poor litigant by reason of the unnecessary expense of that litigation. This is one of the things that calls for an immediate remedy.

"It is not essential that we should make a record of 10,000 printed pages at $50 a day for experts and $100 a day for patent lawyers. I have no objection to experts. I have no objection to patent lawyers, but I think we can have too much of both of them."

Mr. Taft, as a former judge, has had ample opportunities to observe the delays, absurdities, and iniquities of patent litigation in this country. He has seen how patent suits degenerate into mere jockeying and in lawyers' acrobatics, and thus defeat the very purposes for which our patent system was created. In expressing his opinion in su-h non-equivocal terms, he put his finger on the sorest spot of our patent system.

Some time ago, in referring to the hearings of the Oldfield bill for a Revision of the Patent Statutes, I remarked:

"Never before was so much direct information collected on the subject of the working of the U. S. patent system. A large number of representative men, including inventors, lawyers, manufacturers and business men, have appeared voluntarily before the House Committee on Patents; they have had ample opportunity to present their views orally and in writing, and the chairman of the committee, Mr. Oldfield, has shown unfailing courtesy and patience to all who appeared before him.

"It is a noteworthy fact that although there clearly exists a great diversity of opinion among the witnesses as to details of proposed reforms, there seems to be a practically unanimous opinion among those who ought to know best, that the defects of the patent system of this country, as it is now, do not reside in the fundamental patent law, but in the way the law is administered before the courts. Lawyers and inventors alike point out that the methods of patent litigation in this country are so absurd, so slow, so complicated and so expensive, that only rich individuals or wealthy corporations can afford to defend a valid patent against infringers, or to contest the validity of a worthless patent.

"From this standpoint, the patent system of the United States is, as has been said, 'a godsend for wealthy corporations, lawyers, and experts.'

"During the hearings it has been pointed out repeatedly how this could be remedied by adopting the methods of England, Germany, and other countries, by eliminating the present absurd system of taking testimony in patent suits and by the creation of a single final court of patent appeals, instead of the nine circuit courts of appeal which may render conflicting decisions, so that a patent is declared valid in one circuit and invalid in another."

Lately, Mr. Oldfield has published his report. (*Report No.* 1161, *August*, 1912, *from the Committee on Patents, House of Representatives.*) He too lays special stress on the delays and vagaries of court practice in litigation and fully recognizes the evil thereof:

"Two vital changes are essential; the present method of trying patent causes must be abandoned for a new one, and a court of patent appeals must be established.

"*First.* The trial of patent causes.

"Nearly all suits involving infringement of patents are tried in the equity courts, where, according to the Federal practice, the testimony is taken and evidence introduced not in the presence of a judge but before an examiner. The duties of the examiner are little more than nominal. He has no power to direct or limit the inquiry, to enforce the attendance of, or answers from, witnesses or the production of other evidence. He cannot control the examination or cross-examination of witnesses, or determine the relevancy or value of evidence offered, or the propriety of adding to volume. He does not pass upon the evidence, its character, its weight, or its effect. The court, on the other hand, does not in practice undertake to exercise any supervision over the proceedings conducted before the examiner. The judge who is to hear the case knows little or nothing about it until the printed record embodying the mass of evidence put in before the examiner, and supplemented by printed briefs discussing it, is laid upon the desk when the oral argument begins.

"The examiner, the judicial officer who has seen and heard the witnesses, has no function to perform at the argument or decision of the case; and the judge hears the argument upon evidence which he has not heard, and which he has not read. Often when he hears the argument, he is entirely ignorant too of the art and the trade to which it relates. The issues of fact in the case depend often upon the credibility of witnesses; and everyone recognizes that the credibility of witnesses can not be effectively determined except by those who have seen and heard them. The printed word frequently conveys but an inadequate and incorrect measure of the value of testimony. Decisions rendered under such conditions are apt to be unsatisfactory, but this method of trial results in evils far greater than erroneous decisions.

"The time and money wasted in having testimony given orally before the examiner who does not listen to it, then written out by the reporter, and ultimately printed for submission to the judge, who often does not have time to read all of it, is necessarily great. Days or weeks may be honestly consumed with the introduction of evidence on points which the judge, if present, would declare to be clearly immaterial, or if material, to be adequately established in the absence of evidence to the contrary.

"The fact that no means exist for determining the materiality, propriety or necessity of introducing material evidence in the course of the taking of testimony, results inevitably in great waste of time and money. But the fact that the proceedings before the examiner are practically uncontrolled affords also unequaled opportunity for serious abuse of legal processes, opportunities which are unfortunately availed of all too frequently. Proceedings are often dragged along actively for years, and made to involve expenses so great as to be prohibitive for any but the rich. Powerful trusts, litigating with manufacturers of modest means, have found in those legal proceedings one of the most effective instruments of oppression and of confiscation. Law suits conducted under such conditions are apt to result not in determining whether a patent is valid or has been infringed, but whether the limit of endurance has been reached. The immediate result is often a triumph of might over right followed by a rankling sense of injustice and a deep-seated contempt for the law.

"This inefficiency of legal procedure in patent causes tends to accelerate the growth of the trust. Many a small concern has found that it is futile to attempt to seek in the courts redress for infringement of its patents by a powerful trust or that it is disastrous to try to repel a determined attack made under the guise of a patent suit. The small manufacturer yields to the demands of the combination, his poverty and not his will consenting; and relinquishes, often reluctantly, liberty and individuality. On the other hand, when the contest is waged between equal competitors, the long-continued uncertainty due to the necessarily protracted proceedings and the huge expense are apt to suggest combination as a solution of their differences; and in the end they join together in exploiting the public.

"The failure of our law to provide adequate means of determining and enforcing patent rights detracts also greatly from the value of patents to the inventor and other interested persons. It often results also in depriving the public of the benefits which would flow from the development of inventions. This defect in the legal machinery exaggerates the power of the financier. Large capital thus becomes necessary, not for the development of the invention but to protect it. For this reason, the relative value of the required capital as compared with the value of the invention itself is greatly increased, for the most useful invention has been proven to be financially worthless unless buttressed by the large capital necessary to defend the invention legally from attack, either by punishing infringers or by establishing that the invention does not infringe the patents of others. To give due value to an invention in the hands of the inventor or of the small manufacturer, and to insure in the interest of the public the development of all useful inventions, it is essential that an efficient, simple, inexpensive machinery for determining rights under the patent be provided.

"Fortunately, the opportunity for introducing such machinery lies at hand. We have but to follow the methods of trial pursued in patent causes in Germany and in England, which is similar to that prevailing in some of our own States in ordinary equity suits. The evidence should be introduced in open court before the judge who is to hear the argument as soon as the evidence is concluded. The judge is thus in a position to deal promptly and effectively with the whole proceeding. The amount of evidence introduced is greatly lessened because immaterial issues, irrelevant inquiries, impertinent questions may be ruled out. The value of the evidence also may be properly determined because the judge hears and sees the witnesses and may infer from their behavior, intonation, and appearance, as well as from the words spoken, their relative credibility. Litigation which now takes years would, through such a trial, be disposed of in as many months, and where desired could even be disposed of in a few weeks. In the presence of an able judge armed with power to exclude evidence or to enforce its production, and instructed, through his continued presence, in the merits of the controversy, that abuse of the legal process which has become the scandal of the patent practice and one of the most potent instruments of oppression, would cease. Justice, swift and more certain, would prevail. Such has been the experience in the disposition of patent cases in England and in Germany, and no less satisfactory results might be expected in America.

"*Second.* Adequate legal machinery demands also the creation of a court of patent appeals.

"The present system under which it is possible that diametrically opposed decisions may be given by the courts of appeal in different circuits, so that the ultimate decision of rights can be determined only after years of litigation, and the allowance of a writ of certiorari to the Supreme Court of the United States, presents further opportunity for oppression by the wealthy and powerful combination.

"In the Patent Office vital changes also are necessary.

"*Third.* There is great waste of time and expense (which proves a particular hardship to the poor inventor) flowing from interference proceedings designed to determine which of several inventors was the first. The community is really not interested in determining who was the first inventor. The interest of the public is to secure disclosure of the invention. The reward which the public should give in the form of a patent monopoly is to him who makes and first discloses an invention, and every incentive should be given to disclosure at the earliest possible date. The present law gives rather a premium on the withholding of an invention. A man who believes himself to be the original inventor can keep his invention secret, lying by until some other inventor makes application for a patent. A change of the existing rule so as to make the inventor who first discloses, that is, who first files application, the one who is entitled to a patent, would advance the interest of the community and at the same time remove a large part of the evils and oppression incident to the expensive interference proceedings in the Patent Office.

"*Fourth.* Changes should be made in the equipment and organization of the Patent Office to increase its efficiency and to secure for the public and the inventors whom it serves the best possible service. To this end greater opportunities should be afforded the officers and employees of the Patent Office to secure promotion, distinction, and adequate compensation. It should not be necessary for able, faithful, and zealous employees, who are eager to advance the interests of the public, to feel obliged to quit the service in order to secure in private patent practice adequate compensation and recognition of their ability and service.

"If the changes respecting the courts and Patent Office outlined above were made, the public and the inventor would secure further protection from those abuses incident to the great corporations which have been thus described by an eminent inventor, who is the president of the American Institute of Chemical Engineers (Baekeland, *The Journal of Industrial and Engineering Chemistry*, IV, 333):

"'As for wealthy corporations, it has become obvious that the skilful handling of patent cases places them at an untold advantage against their smaller competitors. For them, a well-organized patent department is a reliable machine, where money is the lubricant. This machine, in its slow-but-sure grinding way, can reduce to pulp any of the smaller competitors. For large corporations, the maintenance of such a machine with a staff of lawyers and experts is merely a small side expense. By its aid they can bluff their weaker competitors into quick submission. If this is not successful, they can drag out a patent suit indefinitely, until the weak opponent, unable to bear the ever-increasing expenses, collapses and withdraws.

"'These tactics are well known and have been played successfully, whether it was to uphold a worthless patent or to obtain immunity in case of infringement. In every case, the wealthy corporation is sure of the outcome of the game, and plays, "Heads I win, tails you lose."'

"The Inventors' Guild in its memorial describes the situation as follows:

"'Under existing methods of trying patent causes an inventor-patentee of average means could not, at his own expense, carry to a conclusion an average patent litigation against a wealthy opponent, and, therefore, a few wealthy concerns usually acquire nearly all important patents in their field, to the great damage of the nation, because of the restraint of competition and because of the resulting tendency of such inventors to seek protection for their inventions by trade secrets or else to cease inventive work.'"

Judging from this able and snappy report, there is not the slightest doubt that the public hearings before the Oldfield committee have brought out the most salient vices of our patent system. While presenting this report, Mr. Oldfield has modified considerably his first bill; in fact, he has practically stricken out the original text. Unfortunately, his revised bill does not go at the root of the evil of defective patent litigation, and introduces amendments which, although full of good intentions, carry in themselves dangerous opportunities for clever lawyers to defeat the very purposes for which the bill is intended. Some of the provisions of the bill are so unfortunately worded that they might kill those features of our patent law which aim most at stimulating private research and private enterprise of men of moderate means.

It is an unfortunate fact that most of our legislators, when they speak of patents, have ordinarily in view mechanical patents or secondary inventions; articles like safety razors, alarm clocks, or other objects of simple description which can readily be identified and understood by an average intelligent man without scientific or technical training. To the public at large, most of these inventions seem merely the result of a lucky inspiration, somewhat in the same way as a lucky prospector finds a gold mine, or a lottery ticket draws the grand prize. Even educated men leave frequently out of sight those far-reaching inventions which involve long years of painstaking and expensive research work, where progress is measured only step by step; where able investigators, sometimes groups of specialists trained in science and technology, devote their lives, their efforts, and often all their cash, to elaborate a difficult industrial problem.

To such a class of inventions belong many of the chemical processes. Yet one of the men of the Congressional Committee on Patents seemed to be under the impression that chemical inventions were mostly intended for the manufacturer of pharmaceutical substances. To the uneducated public, the thought of "patent medicine" enters easily in the mind as soon

*Slightly abridged from the *Journal of Industrial and Engineering Chemistry.*

as reference is made to chemical patents. Few, indeed, realize that some of the chemical processes have brought about far-reaching developments, not only in other industries, but in civilization itself; we might mention, for instance, the Goodyear rubber process, which made the automobile possible, the invention of dynamite without which gigantic engineering enterprises like the Panama Canal would be utterly impossible, the cellulose processes, which contribute more to the diffusion of knowledge and culture by the printing press than any other factor, the Bessemer Steel process which furnished us cheaply and abundantly the main raw material for all our engineering, the synthetic processes of the coal tar products which brought forth the most astounding series of applications in therapeutics, surgery, hygiene, art, and general technology, etc. Fewer still are aware that most chemical patents are so-called "process patents," and on this account are least protected against pirating infringers, who always lay in wait for the pioneer, as soon as the latter has, after untiring efforts, succeeded in demonstrating the value of a new process. Only those who have passed through the worry and trying ordeal of pioneership, know what it means to bring to successful issue a new untried chemical process.

Even the theoretical or laboratory chemist, who never was engaged in any industrial pioneer work himself, can hardly conceive that after an invention has been thoroughly studied in the laboratory, nay even after it has been run on a small industrial scale, in most cases, only about ten per cent of the real work of pioneering has been accomplished. In the majority of cases, lack of funds, lack of manufacturing talent, defective commercial organization, and many other conditions bring forth failure, sorrow and financial loss.

Again, in many instances, it is easier to make the invention and to bring it to technical perfection, than to persuade the public of its advantages. The latter attempt means long tactful and expensive educational work. Unless the pioneer feels that for a short period at least, he may have the absolute monopoly of his inventions, what inducement is there to sacrifice his time and money on a result already too doubtful in itself? Many inventions have gained recognition only *because they were patented* and thus it was worth while to spend money and to show their merits to the public. Other inventions have never received the attention they deserved, because nobody cared to take the risk of educating the public up to them. The metric system was invented by the Arabs many centuries ago, and its benefits are not yet recognized by the business men of this country. If the metric system had been patented, it might, after one generation, have become as popular as "national cash registers."

But just this work of education means, in many cases, an immense amount of money and effort, with all the risks of loss. And then, after you have disclosed accurately your intention in the text of your patent, as the law demands; after you have educated the conservative public to the advantages of your process, then it happens almost regularly that those who at first most strongly denied the advantages of your invention, nay, sneered at its claimed possibilities, then simply turn infringers; after every detail of the invention has been carefully explained to them, they calmly declare that there is no invention, and begin to appropriate to themselves all the work of your pioneership. These modern buccaneers have no use for good patent law, or if they tolerate any patent law at all, it must be of such a nature that it can not be enforced. They, too, howl for "patent reform," and unfortunately, howl loudest, but they want patent reform which would kill the best there is in our patent system, and they speak little about reform in court practice. *If our system of court practice had purposely been devised to help the patent pirate, it could not much be improved upon.*

Our laws are painfully strict in protecting so-called "vested property rights," and this protection extends to the most trivial matters. If Tom steals Dick's two-dollar scarf pin, Dick will have no trouble in putting Tom in jail, even if Dick himself has obtained his pin by questionable methods. But when it comes to protecting even for the short period of seventeen years, the most legitimate, the most truly personal property, namely, intellectual property, with all that it involves, with enterprises depending thereon, based often on the work of a lifetime, then our law courts are wofully deficient.

Any system of law which does not adequately protect intellectual property so that rich and poor alike can uphold their rights, is an anachronism in modern civilization.

Geared Steam Turbines*

Their Development for Ship Propulsion

By Sir William H. White

THE PARSONS GEAR.

THE practical use of mechanical gearing applied to steam turbines for ship propulsion was initiated in England by Sir Charles Parsons so long ago as 1897, and has been carried much further here than elsewhere by him and his colleagues.

The most important facts of this new chapter in the history of marine propulsion may be found in the *Transactions* of the Institution of Naval Architects for the last three years. As these facts are easily accessible it is unnecessary to recapitulate them except in bare detail. The first application of the geared system was made by Sir Charles Parsons in 1897 in a small steam launch of 10 horse-power, in which a single turbine was geared to two wheels, each of which drove a propeller shaft. In 1909 the cargo steamer "Vespasian," of about 2,150 gross tonnage and 4,350 tons loaded displacement, was purchased by the Parsons Marine Steam Turbine Company; and after exhaustive trials had been made of her performances when driven by the reciprocating engines with which she was then fitted, these engines were removed and geared turbines were substituted. The maximum power developed with the turbines of the "Vespasian" was about 1,000 horse-power. After a series of exhaustive trials, which gave data for scientific comparisons of the respective performances with reciprocating engines and with geared turbines, the Vespasian returned to her ordinary service as a cargo steamer. Up to March last she had covered more than 40,000 sea miles with complete success, and on service had given full confirmation of results obtained on the experimental trials in regard to fuel economy. The scale of these experiments as compared with the engine powers necessarily developed in swift sea-going steamers was, of course, modest; on the other hand, it must be regarded as considerable for an experiment made by and at the cost of a private firm. The "Vespasian's" performances as a test of the endurance in actual service of geared turbines on shipboard still remain unrivalled and constitute the most important evidence yet available in that regard.

Confirmation of possibilities anticipated for geared turbines having thus been obtained, the application of the system has since been extended by Sir Charles Parsons and those associated with him. Up to the present fifteen vessels have been built or are building to be driven by geared turbines of the Parsons type, the aggregate power dveloped by their machinery exceeding 100,000 horse-power. This progress in so short a time is remarkable when it is remembered that the earliest stages in the use of any new invention are almost necessarily marked by much slower advance than is subsequently attained. The history of the Parsons steam turbine itself, and more especially its marine applications, furnishes a striking illustration of this general statement; and it is certain that before long much more extensive use will be made of geared turbines in many classes of ships, both for war and for commerce. Among the fifteen ships already fitted with this type of propelling apparatus there are included cross-Channel steamers, ocean-going passenger steamships, cargo vessels, and destroyers. Experience and experiment have demonstrated the possibility of the transmission of very large powers through mechanical gearing, in association with the maintenance of high efficiency, practically negligible wear of the gearing, and freedom from objectionable noise.

One of the most important and most recent applications of the geared system is to be found in two Channel steamers which entered on the service of the London and Southwestern Railway Company during this year. Particulars of these vessels and of their contract trials have been published by Prof. Biles, on whose advice the new system was adopted in their design. The maximum horse-power developed on the trials was about 6,000 horse-power, corresponding to a speed of 20.4 knots. Prof. Biles has stated that the water consumption for the propelling engines of one of these vessels was 12 pounds per shaft horse-power per hour, as compared with 15 pounds for similar vessels fitted with turbines driving direct; and it is understood that on actual service the relative fuel economy has been fully maintained.

APPLICATION TO LARGE POWERS.

Experience so satisfactory as that above described has naturally led to the application of geared turbines to greater powers. In one of the eighteen vessels now building about 14,000 horse-power will be developed, and still greater powers are contemplated in the immediate future, both for warships and for vessels of the mercantile marine. In considering possible applications of the new system Sir Charles Parsons and those working with him were naturally led, at a compartively early date, to the preparation of designs for geared turbines applied to the propulsion of battleships, battle cruisers, and other types of warships. Every one familiar with warship design cannot fail to realize the exceptional importance which would necessarily attach to economies of weight, space, and consumption of steam and fuel made possible by the use of smaller quick-running turbines of high efficiency which transmit their power through reducing gear to propeller shafts. Lower rates of revolution of the latter undoubtedly tend to secure increased propeller efficiency; and the quick-running turbines favor reductions in weight, space, and steam consumption. Losses in transmission through mechanical gearing have been proved to be extremely small, so that the "total efficiency" of propulsion with this combination of slower-running propellers and quick-running turbines is necessarily superior to the total efficiency of turbines of larger size running at a lower rate of revolution and driving direct on the propeller shafts, although it has been demonstrated that the latter combination gives great advantages as compared with reciprocating engines.

While these general results represent experience up to date, it is but proper to remark that the decrease of propeller efficiency consequent on increased rates of revolution which have been adopted in turbine-propelled warships (as compared with reciprocating engines) has undoubtedly been much exaggerated by some writers in their advocacy of reducing gear. Experience has shown that with direct-driving turbines and a high rate of revolution (as compared with the maximum rates usual with reciprocating engines in battleships and large cruisers) it is possible to obtain good propeller efficiency, although the highest value is not attained. In the present state of knowledge, however, more certain results as regards propeller efficiency can be obtained generally in association with more moderate rates of revolution. In the design of the "Lusitania" and "Mauretania" this principle to a great extent governed the turbine designs. The committee which dealt with the subject, after full consideration, advised the adoption of a rate of revolution of about 180 a minute, which did not exceed the rate which had been adopted with reciprocating engines in the swiftest war cruisers then built. It is understood that the same principle has been applied in the design of the still larger turbine-propelled transatlantic steamers now building in Germany and in Great Britain.

OTHER FORMS OF REDUCING GEAR.

Alternative systems of reducing—either hydraulic or electric—which have been put forward by British and foreign engineers have not as yet undergone practical test on a large scale, and, therefore, need not be dealt with at any length. In the United States a collier is now being built in which electrical transmission on the system advocated by Mr. Emmet is to be fitted, and the trials will be of great interest. The hydraulic system of Dr. Föttinger is to be tested in a large transatlantic steamer belonging to the Hamburg-American Line, with a normal horse-power of 18,000 and an overload capacity of 23,000 horse-power. It has also been stated that the application of this hydraulic system to still greater powers is contemplated. Dr. Föttinger says that 88 per cent efficiency in transmission has been guaranteed for large powers with his hydraulic system. With mechanical gear the corresponding efficiency has been proved to be above 98 per cent. With mechanical gearing an astern turbine is required, but experiment shows that the losses involved in driving such an astern turbine when the propelling machinery is moving at full speed ahead is very small and does not involve any serious loss. Sir Charles Parsons estimates it at not more than 1 per cent of the maximum power developed, and having regard to the much smaller loss in transmission with mechanical gearing as compared with hydraulic this waste work, of course, becomes relatively unimportant.

* Reproduced from *London Times Engineering Supplement.*

From the foregoing statement it appears that the present position in regard to the employment of quick-running turbines in association with reduction gear is one of great interest; and it may be hoped that many questions will soon be settled by experience which are for the time being necessarily matters of opinion and estimate. Whatever system may prove the best and most efficient on the whole, the conclusion is inevitable that by the use of some reducing gear a still further step will be made possible in the association of lightness with the development of power in marine propelling apparatus and in economy of steam and fuel consumption in war fleets and in the mercantile marine. In the case of cargo steamers of moderate and low speed it also appears probable that geared turbines will find employment, although the competition of the internal combustion engine, and of the Diesel engine in particular, in vessels of this class and of low power, may play an important part. It is unnecessary to enlarge on this aspect of the question because those interested therein will find it fully discussed in the *Proceedings* of the Northeast Coast Institution of Engineers and Shipbuilders for the current year. The conclusion reached by Sir Charles Parsons and expressed in the course of that discussion is, however, worth notice. He said: "With the geared turbine and 100 degrees of superheat the cost of running a vessel with coal at 15 shillings a ton would be the same as with the Diesel engine with oil at 23 shillings (per ton)." If this estimate is correct, and there is no reason to doubt it, then the chances of the extensive use of geared turbines in future tramp steamers should be good; because there seems no probability of an approximation being made to such a low price of oil, particularly if very large quantities of oil were required for marine propulsion.

PREVENTION OF NOISE AND WEAR.

Prof. Biles, in his paper on the new Southwestern Railway steamers, said that the trials of the "Normania," "proved to those who were on board that the anticipation that the noise of the gearing would be negligible was a correct one," and it is understood that subsequent experience on service has confirmed that favorable verdict. In other cases where geared turbines have been used experience has been equally favorable, and with well cut mechanical gearing running in oil there should be no trouble from this cause.

As regards the necessity for or the desirability of having something in the nature of a "floating frame," it may be said that no similar arrangement has been fitted hitherto with Parsons geared turbines, nor has there been any evidence in these vessels that elasticity in the bearing is necessary or important for the automatic elimination of unequal tooth pressures. Whether or not with very large powers some such elasticity in the bearings may prove desirable is a matter which will be decided by experience. If there should be evidence that such elasticity is desirable it can be provided readily; but experience up to date, and with powers much exceeding the power installed in the collier "Neptune," shows that the Parsons system of gearing has been successfully applied and worked for long periods without any such feature having been found necessary.

The Flashing Arcs*

A Volcanic Phenomenon

By Frank A. Perret

On the afternoon of April 7th, 1906, the present writer, in company with Prof. Matteucci, was skirting the southern flank of Vesuvius on a trip to the main source of the lava at the Bosco Cognoli. The volcano at this time was entering one of those paroxysmal phases by which the eruption—already three days old—worked progressively up to its great culmination, which occurred, it will be remembered, between this and the following day. The ejected detritus was of a mixed nature, viz., the fresh lava, clear red in full daylight, being mingled with old material from the upper portions of the cone, then in process of rapid demolition. The frequency of the explosions varied from approximately one every three or four seconds to at least three per second. Although powerful, they were very sharp and sudden in their nature, and at the instant of each—but before it could be sensed by the eye or ear—a thin, luminous arc flashed upward and outward from the crater and disappeared in space. Then came the sound of the explosion and the projection of gas and detritus above the lip of the crater. The motion of translation of the arcs, while very rapid in comparison with that of the detritus, was not above the limits of easy observation and there could be no doubt as to the reality of the phenomenon, which was repeated some hundreds of times.

The writer attempted photography but without success, the failure being due in part, perhaps, to the velocity of the arcs and their very moderate brightness, but also most certainly to the extreme unlikelihood of the shutter being snapped at the precise instant of the apparition. One of the photographs is reproduced in Fig. 1, and I have permitted myself to trace upon the negative film with aniline two circles which print out in the approximate appearance of the arcs, assuming these to have been arrested instantaneously during their up- and out-springing form the crater.[1] It should be stated that this illustration, because of its crudeness and the lack of motion, conveys but a poor idea of the actual phenomenon, the beauty of which lies in the delicate luminosity, the elegance and perfection of form, and the grace and vivacity of the arcs amid the contrasting color and relatively sluggish movement of their surroundings.

During the extraordinary activity of Stromboli in 1907 the writer did not observe the flashing arcs although some of the explosions appeared to have the qualities which should have produced them, but the place of observation was probably too near the crater. The small eruption of Etna in 1908 was not observed, but the conditions were not, in my opinion, such as to have reproduced the phenomenon. At Teneriffe in 1909, although incandescent lava was still available for research work upon my arrival, the explosive effects, which had been powerful, were virtually at an end, and it was therefore with the greatest delight that during the 1910 eruption of Etna I again observed the flashing arcs.

By a rare good fortune the explosions in this case were almost without detritus, thus forming a condition the very opposite to that at Vesuvius in 1906. It will be remembered that this eruption of Etna produced a fissure two kilometers in length over which were formed some twenty-four small craters. The explosive forces were thus so subdivided and distributed that no very large cones of scoriæ were built up, many of the craters being little more than holes in the ground. One of these, although larger than the average, was so perfectly free from surrounding débris that a post-

Fig. 1.—Circles Indicate the Appearance of the Arcs.

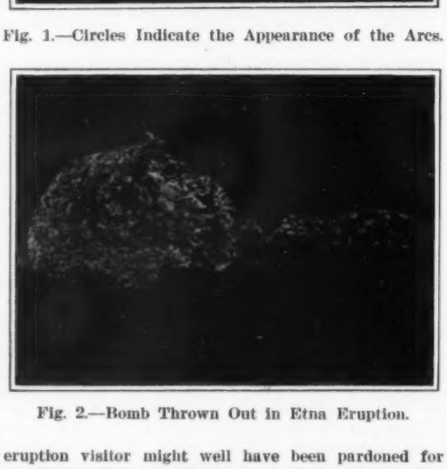


Fig. 2.—Bomb Thrown Out in Etna Eruption.

eruption visitor might well have been pardoned for considering it the least important of the entire series. It was, however, the seat of all the heavier explosions, each of which hurled one or two bombs of stiff, incandescent lava to a considerable distance, but without any accompaniment of ash or other detritus. On the morning of March 30th bombs as large as a meter in diameter were ejected (Fig. 2), and these explosions produced the flashing arcs which were in all respects identical with those of Vesuvius. Until they were pointed out to him my guide did not observe them, and it is quite possible that I myself might not have seen them had I not known what to look for, as the absence of a darker setting and the lesser distance of the viewpoint rendered them more difficult of observation than at Vesuvius. Some fifteen were clearly seen by us, all the stronger explosions producing them.

What is the nature of this phenomenon? The only hypothesis which seems in accord with the observed characteristics sets forth a proposition which, at first thought, may seem almost startling, viz., that we have to do with *visible sound waves*. According to some far from accurate measurements made on the spot the velocity of propagation of the arcs *seemed* to correspond with that of sound. We may certainly assume the outburst to be spherical or at all events globular, as though a huge soap bubble were rapidly blown from the crater and that the edge alone is visible and therefore appears from any point of view as an arc. The movement of this visible portion will therefore be at right angles to the line of sight and the arrival of the sound—from the crater radially to the observer—must be compared with the arrival of the arc at some point equidistant from the crater but at right angles to this radius. As the arcs rapidly fade into invisibility with increasing distance from their source the difficulty of accurate measurement will seem to be very great.

But if we attack the problem by the way of exclusion we shall find, I believe, that the velocity—even assigning to it values having a considerable margin above or below that of sound—can be made to harmonize with no other mode of motion. Actual mass movement, i. e., motion of translation of any material, solid, liquid or gaseous, is negatived by the flashing of the arcs amid the relatively slowly rising and perfectly undisturbed volutes of vapor and detritus as well as by their direction of propagation, which is outward and downward as well as upward. On the other hand, any attempt at explanation on the basis of Hertzian or electromagnetic effects, due possibly to stress relief, etc., must also be excluded on the speed basis, which now becomes much too low.

After all is said, is there any real difficulty in accounting for the flashing arcs on the basis of the proposed hypothesis? Sound is propagated in air by compressional-rarefactional waves projected normally. The conditions for the production of the arcs are sudden explosions on a large scale. Given these in sufficiency, may we not imagine that in the resulting aerial condensational-rarefactional wave—or sheet of superposed waves—the refractive and reflective indices will be so altered as to form in bright daylight a zone visible by contrast, especially when viewed longitudinally, i. e., through the edges of the transparent sphere? We are familiar with the visibility by contrast of the refrangibility of hot and cold air, and it would seem that mechanically engendered compressional-rarefactional aerials waves should be visible in the same manner if sufficiently accentuated. It is a question of the *degree* of condensation and rarefaction, and this evidently depends directly on the power and inversely on the time factor. The proposition will be more truly scientific and possibly more acceptable if stated thus: An explosion propagates normal condensational-rarefactional waves in air—these are perceived by the ear as sound and may also be visible by unequal refraction when sufficiently powerful.

As observed by the writer at Vesuvius and Etna, the flashing arcs may be considered one of the most beautiful of all volcanic phenomena.

* Reproduced from the *American Journal of Science*.

[1] It may be that I have centered the circles too high above the crater.

Native Placer Mining in Colombia*

Primitive Tools Sometimes More Efficient Than Those Listed in Modern Catalogues

By R. D. O. Johnson

THE equipment of the native placer miner in Colombia is secured from the forest or jungle adjacent to his operations. Beyond the ubiquitous machete he needs no assistance in the way of tools from the outside world.

A knowledge of the tools, devices and methods evolved out of the necessities of the isolated native's way well serves the needs of the prospector or miner who finds himself far from his base of supplies and with no means at hand for drawing upon a stock of modern appliances. Moreover, it is not infrequently found that the native tools and appliances are better adapted to the work for which they were developed than any that are listed in the catalogues of mining-supply houses. Upon his advent into this country, the American prospector discards the gold pans he has brought in his kit for the *batea*, and falls as naturally into the use of the *almocafre* (Fig. 5), as though he were born to it. This instrument, which originated with the aborigines in prehistoric times, combines the virtues of the pick and hoe without the faults of either and with many virtues of its own.

SPANIARDS EXHAUSTED HIGH-BENCH GRAVELS.

It is probable that before the advent of the Spaniards into South America, the placer-mining operations of the aborigines were confined to the washing of the *eventaderos*, or high bench gravel, that could be made to yield their gold by the employment of simple methods, such as ground sluicing. The adventurous and energetic Spaniards promptly turned their attention to whatever was left of these easily worked deposits, the product of which for many years kept filled the coffers of Spain. The exhaustion of these deposits led to the working of other but less favorably situated ground, until today there remains the rich river beds and the water-filled playas, or river bottoms, which latter have baffled the best efforts of the Spaniards and their home-made apparatus.

The river beds can now only be worked during long continued dry seasons. A few tropical downpours puts a stop to native river mining. The gravel in the beds of many of these rivers is rich, estimated in some cases at from $4 to $10 per cubic yard. That these gravels are rich is evident from the yield, considering the primitive methods employed in their working and the small quantities actually washed.

WOMEN EXPERT OPERATORS.

When the dry season is well advanced and the waters of the rivers have fallen to a low point, the peons and their women flock to the river sides. They proceed to construct rude shelters with palm-leaf roofs and to "camp on the job." At such times the supply of labor for mining and agricultural purposes runs low, and wages must be raised to match the lure of the river.

The women as well as the men are expert operators with the *batea*. The woman generally work independently of the men, employing in their washing operations the large spoon *batea* with the handle, as shown in Fig. 1. These *bateas* seem not to be made of any standard dimensions, the bowls varying in length from 3 feet to 6 inches, in width from 20 to 28 inches and in depth from 4 to 6 inches. Handles are from 12 to 14 inches in length. Like all other *bateas*, these are cut from the solid wood, some artisans acquiring great reputations for their skill in making them. Armed with these huge *bateas*, the women wade out into the river, usually selecting as the place for the operation a point at the up-stream end of the bar or a rise in the river bed, such a point being thought the most favorably situated for the deposition or concentrating of the moving gold. It is not an unusual sight to see from six to a dozen women in a line across the central part of a gold-bearing river up to their waists or arm-pits scooping up the gravel from the bottom with these great wooden bowls.

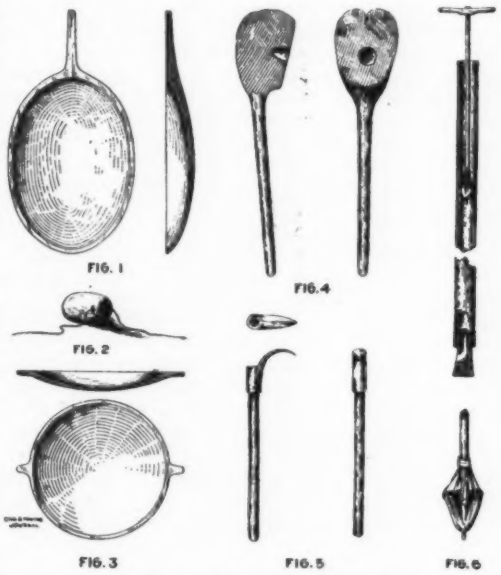
GRAVEL WASHED DOWN TO BLACK SAND.

The *batea* is employed as a shovel in digging up gravels, the convex side being invariably turned up-stream. In washing the gravels, the *batea* is floated on the water surface and given a peculiar rocking, swashing movement that rapidly and effectively concentrates the charge to the black sand contents. The movement allows water to enter the bowl over one edge, and after having completed the circuit, to escape near the point of entrance, washing overboard the lighter parts of the charge. The washing is completed, so far as this operation is concerned, when black sand only remains. This is washed into a small gourd (Fig. 2), that is fastened to the waist by a string and held in front.

At the end of the day the contents of the gourd are cut down in a small *batea* of the pattern as shown in Fig. 3. The gold obtained by this washing process is fine, the gravel treated being taken from the tops of shifting bars. The quantity actually handled per day probably does not exceed seven or eight cubic feet. The returns vary from 20 cents to $2 per day, depending upon the locality. When it is considered that the prevailing wage for women is from 10 to 15 cents per day, the return of the washing operations are properly regarded as magnificent.

NATIVES FORM ARTIFICIAL BARS.

A somewhat more ambitious method of treating the river gravels and getting at those lying on bedrock, is known as the *sombre* method. This is generally undertaken by the men, two, four or more working together. A line of eight or 10 stout stakes, spaced from 18 to 24 inches apart, are driven at the point selected, the direction of the line being at right angles to the direction of the river current. The stakes are from eight to 10 feet in length and are driven through the bed of sand and gravel into the decomposed granite bedrock. The stakes are braced on the downstream side by inclined stakes. These are bound to the vertical stakes by *bejucos*, a kind of stout though soft and flexible vine. The vertical stakes stand above the water about 18 inches, and on each side of these stakes near the top, a horizontal pole is bound. These two poles serve as a platform from which the shovelers work. In a vertical position on the up-stream side of the vertical poles, is placed a mat made of palm leaves. This mat is adjusted in a position so that its lower edge stands but a short distance above the top of the bed of sand and fine gravel that usually overlies the coarser and more compacted stratum of gravel on bedrock. The sweep of the water underneath the mat carries off the lighter sand and gravel and piles them up in the more quiescent water below the *sombre*, as the poles and mat are collectively called. The women are always anxious to wash these artificially formed bars. When a sufficient amount of coarser gravel has been uncovered, the mat is moved down to obstruct the flow of water as much as possible and shoveling commences. The shovels are provided with handles 10 or 12 feet in length. Not infrequently the natives employ in the place of shovels a kind of wooden scoop provided with a long handle.



Native Colombian Placer-mining Tools.

BEDROCK NOT THOROUGHLY CLEANED.

The amount of gravel that can be raised by two or three shovels is washed in a large *batea* (Fig. 1). Sometimes six shovelers and two washers may be seen working at one *sombre*. Usually the gangs consist of three or four men. This methods yields much higher returns for the labor than simply washing the upper stratum of sand and gravel. The shovelers frequently, though not always, reach bedrock, but it is impossible for it to be thoroughly cleaned by this method. Only a narrow strip of gravel, perhaps two or three feet in width, is uncovered by the water flowing under the mat and made available for shoveling. So energetically has this kind of mining been pursued in some rivers that the water flows through forests of stakes.

The method of driving the stakes is unique. The stakes are green hardwood and would split and be rendered useless long before they had penetrated the bedrock if driven by a maul or sledge hammer of usual pattern. Since iron rings or ferrules are unavailable or unknown, the natives devised a scheme of their own that is entirely satifactory. The stakes are pointed at both ends, the upper end being rather blunt. The maul (Fig. 4) is made of tough, gnarly wood and is provided with a conical pocket into which the end of the stake fits. In driving, the blunt pointed end of the stake enters the conical pocket, the effect being to drive the fibers of the wood together and thus to prevent splitting.

PITS SUNK DURING DRY SEASON.

During long continued droughts, many of the lower river bars are exposed. These exposed bars are favorite places for the carrying out of another class of river mining. In these are sunk pits 12 to 14 feet square, they are first excavated to a depth of one foot and a frame of heavy round timbers is put in. Outside of this frame stakes are driven separated by spaces of three or four inches. Excavation then proceeds, the gravel and sand being carried out in hand barrows.

As the stakes are exposed, the long grass-like leaves of the *caña brava* are laced in behind, presenting a tight and effective screen against the influx of sand. In these bars there is frequently, not to say usually, encountered a kind of fine clayey sand or *mole* which, when filled with water, as it generally is, presents the most difficut problem the native placer miner is called upon to solve. This *mole* is found also in thick strata in the playas always below water level.

It is the presence of this treacherous material that is largely responsible for the fact that there exists to-day many promising playas awaiting exploration by Americans with modern machinery. When the native encounters *mole*, it is a question as to whether or not he will succeed in excluding it and get to the "pay" below. He depends upon fern leaves and the leaves of the *caña brava* laced in between and behind the stakes. If the bed is heavy, the influx from below may be so strong as to compel the abandonment of the pit. However, if he succeeds in conquering the *mole* and the flow of water is not too great, the remaining part of his work is comparatively simple. The *cinta* or stratum of gold-bearing gravel lies just below the *mole*. It is loosened by the *almocafre*, shoveled into hand barrows and carried up the runways, made of logs flattened on top, to a long tom, or short sluice, where it is washed.

In shoveling the place presents a peculiarity that is viewed with scant patience by the American miner, particularly if he has absorbed some notions of scientific management. If the hand barrow sitting on the runway is at an elevation slightly above the shoulder of the shoveler, he declines to make the effort to raise the material, but insist upon having the assistance of another peon at his elbow, the duty of this auxiliary being to hold a small *batea* into which the gravel is shoveled. The auxiliary peon then raises the *batea* with the shovelful of gravel and dumps it into the hand barrow. As the shoveling point is 10 feet away from the hand barrow two auxiliaries are employed to pass the *batea*.

THE NATIVE PUMP.

Water is removed from the pits by means of hand pumps constructed from materials found near at hand. Within their range these pumps are effective. The tube is made from the trunk of a particular kind of palm tree. The soft, pithy interior is scooped and bored out by means of an instrument resembling the spoon or earth auger of the Empire drill. The interior diameter of the tube is between three and four inches, the length from 10 to 14 feet. The valve end of the tube is bound tightly with strands of native rope placed in circular grooves. This is to prevent splitting of the tube when the valve plug is driven in. The valve plug, 12 to 14 inches in length, is bored hollow for half its length and an opening is cut to communicate with the outside. The wood-capped leather valve is nailed on the end of the valve plug that is inserted in the tube. The lower and solid part of the valve plug serves as a foot for the pump keeping the intake opening above the sand and gravel of the bottom.

PUMP IS ADAPTABLE TO ALL CIRCUMSTANCES.

Perhaps the most unique feature of the pump is the

* Reproduced from *The Engineering and Mining Journal*.

plunger, piston or bucket (Fig. 6) though none of these names defines it. A pole four to five feet in length and having a diameter of 1 to 2¾ inches is fitted with a cross handle like the handle of a gimlet. The other end of the pole is cut to a smaller diameter for a distance of 1½ inches from the end, leaving a shoulder. This part of smaller diameter is passed through a hole of equal diameter in the center of a disk of green or thoroughly soaked rawhide. The diameter of this rawhide disk is from six to eight inches, depending upon the diameter of the bore of the tube. To the outer edge of this disk and equally spaced are fastened six rawhide straps about six inches in length and three-fourths of an inch in width. These straps are nailed or tied to the pole at such a distance above the shoulder as to allow the soft disk to form a pocket or sack, the outer diameter of which, when expanded by the pressure of the water, will be sufficient to permit a more or less tight fit in the working barrel of the pump tube. The flexibility of the plunger allows it to fit all the irregularities of the interior of the palm stalk crudely fashioned as it usually is. Riveted sheet-iron pipes of four, six, or eight inches in diameter may be readily converted into hand pumps by the use of such valves and plungers. The rivet heads inside of the pipes seem to have no effect upon the working efficiency of pumps thus constructed, so great is the adaptability of the flexible rawhide plungers.

The pumps in their working positions stand at angles from 35 to 50 degrees from the horizontal and raise water from six to eight feet in vertical height. One lift is usually sufficient for pits sunk in the sand bars of the rivers. Where one lift is not sufficient, one side of the pit is cut down and a shelf is formed. The water is raised by one series of pumps from the bottom to the shelf and by another series from the shelf to the surface. As depth is gained and the flow of water increases the pumping keeps pace by increasing the number of pumps. In extreme instances as many as 20 pumps have been used to keep a 12x14-foot pit free of water. As the work of each pump operator is equal to that of every other, and as the pay is equal, the boss of the pit insists on synchronous movement. If all keep time with the pacemaker no one is loafing.

PARTS OF RIVER CUT OFF BY DAMS.

The most ambitious of all the native engineering projects for reaching the gold in the river bottoms is known by the name of the *tapado*. The *tapado* might be defined as a wing dam that bends back to the bank inclosing and cutting off a part of the river bed. The dam is constructed by driving stakes close together in a double line and filling the space between the lines with clay, well tamped in. The lines of stakes are separated by a space of about four feet. The stakes are fastened together by binding all to horizontal poles placed near the top. These horizontal poles are then bound to cross poles placed about every four or five feet. Vines, *bejucos*, from the jungle are used for the binding. Previous to filling in with clay, palm leaves are placed inside and against the stakes. When the *tapado* has been completed, the water is pumped from behind the dike and mining proceeds. At points near riffles or cascades, the *tapado* dam may be run out from the bank above, and terminate at a lower level, going down the riffle. If the fall is greater than the depth of the water outside of the upper end of the *tapado*, the lower end is left open and no pumping is required, as the space inside drains itself.

At most of the large mines on the Porce River, where the playas are being worked by means of hydraulic elevators, the operators take advantage of a protracted dry season to put large *tapados* into the river, thus making accessible considerable additions to their workable territory. Since the borders of the playas adjacent to the river are almost without exception the richest parts, the areas thus added are highly remunerative.

LEASING SYSTEM POPULAR.

The river workers generally consume so much time in building their tapados that little is left of the dry season for the work of getting at the bedrock. Partly for this reason and partly from the fact that the natives find it the usual thing to do, the *corte* system consists in leasing small *cortes*, or areas within the mine or *tapado*, for a percentage of the product. This percentage depends upon the expected total yield and upon the live lines of the competition for the opportunity to work a *corte*. If the mine or *tapado* has the reputation of being rich and competition is active, the owner may demand and get as high as 50 to 60 per cent. of the gold produced. On the other hand, he may not be able to secure leasers unless he concedes to them 80 per cent of the product.

WAGES DEPEND ON AMOUNT OF GOLD RECOVERED.

The river workers are always required to pay 20 per cent of their gross washings to the owners of the mines. The river miners have unlimited opportunities for concealing the amounts of gold they actually wash out, and their incessant shifting from one mine to another makes it a hopeless task for the owners to keep track of them. It is safe to say that a portion much smaller than 20 per cent gets into the pockets of the owners.

The owners of the *tapados* keep out the water, receive, weigh and sell the gold. The lessees frequently sublet their privileges. The peons sometimes receive their food and lodging only and are promised a proportional division of one half of the gold that falls to the share of the lessee or sublessee after he has paid his percentage. Sometimes the peons prefer to board themselves, particularly if they have families. Since they invariably live from hand to mouth, they must have some pay. In that event their employer contracts to pay them one half of the ruling wage and promises a proportional division of one quarter of his share of the gold to complete their pay.

At other times the peon receives something less than the ruling wage and is promised by his employer a *pinta* as a final settlement. This is the product of a *batea* full of gravel taken from the bedrock. On the Porce River, 95 per cent of all the gold is on bedrock or within a foot of it, so this method is sometimes highly satisfactory. The peon is always ready to take a gamble in a small way.

GRAVEL CARRIED FROM THE PITS.

The operating force for each *corte* usually consists of one shoveler, rarely more, *batea* passers, hand-barrow carriers and washers, who wash the gravel and attend to the sluices. The lessee or sublessee generally acts as *capitan* or boss. Each pair of hand-barrow carriers will carry the loaded barrows a distance of only 25 to 40 feet, depending upon the steepness of the runways. As many as four to seven pairs of carriers are employed for each *corte*, where the runs are from 200 to 300 feet in length. The transportation of the gravel for such distances is not infrequent at the playa mines, in which the gravel is from 40 to 50 feet in depth.

As stated elsewhere, the wages of the peons are higher during the dry seasons, so that the cost for each peon (wages and food) will not be far from 70 cents per day. During the wet seasons plenty of good peons may be employed at a total cost of 50 cents per day each. The hand-barrows as loaded hold from 1 to 1¼ cubic feet. From 3 to 5 cubic yards of gravel are removed from each *corte* per day at a cost of from 80 cents to $2 per cubic yard. It takes good ground to stand such costs and to produce a profit. The *corte* system has been defined as the one designed to distribute the product of the mine to the greatest number of Colombians.

BEDROCK NEVER THOROUGHLY CLEANED.

Within the last eighteen months the native miners have learned a lesson from the Americans, who are putting in hydraulic elevators for the purpose of working the deeper water-filled gravels of the playas. The depth of the gravels range from 12 to 55 feet. Up to the present, these more progressive miners seem to have been so inadequately supplied with capital that their elevator equipments are too small to do more than serve as pumps and keep the pits fairly clear of water. These water elevators are so far superior to the old-time overshot water wheels used for driving four to six pumps, that the latter are now being but little employed. These ponderous slow-moving contraptions were never more than partially successful and enabled the miners to reach only the highest portions of the bedrock. The same ground formerly mined by natives with the aid of these water-wheel-driven pumps has since been washed by Americans, using hydraulic elevators with most satisfactory returns. The mining done by the Americans developed the fact that the natives of former times had succeeded only in cleaning up the ridges of the bedrock, whereas the best of the gold was found in the depressions. Thus a rich harvest was left for those who arrived late upon the scene.

Economy Due to Superheated Steam in Marine Practice*

Increased Thermal Efficiency Gained Without Additional Cost for Repairs

By Walter M. McFarland

THE theoretical advantages of the use of superheated steam were evident at an early date, as indeed would be inevitable when the principle of the Carnot heat cycle was understood. In the early days, when materials were not nearly so good as at present, and steam pressures were accordingly much lower, the benefit of getting the economy due to a very much higher initial temperature with no increase of pressure was, of course, obvious. Accordingly, very many experiments were made and a number of plants were installed using superheated steam, often with special superheating boilers. On the whole, these early installations were not practical successes, on account of the rapid corrosion of the superheaters, although the heat economy was obtained. In those days workmanship was not so good as now, and the causes of corrosion were not only not properly understood but there was dense ignorance concerning them, so that the measures taken to prevent corrosion really increased it. Obviously, there was no commercial economy in a system where the cost of repairs far exceeded the saving due to increased economy.

In more recent years, since corrosion has been better understood and the means for preventing it are fairly well known, the attractiveness of the benefit to be derived from superheating has led to its reintroduction, and this article is intended to be a brief discussion, with some illustrative examples, of the economy which comes from the use of superheat.

In land installations, where poppet valves can be used, so that the question of valve friction does not come up, superheat may be used to almost any degree that is desired, and there are a great many examples of such engines on the continent of Europe which are working with a remarkable degree of economy, in some cases very closely approaching 1 pound of coal per horse-power hour.

With the steam turbine, where there are no rubbing surfaces, the benefit to be derived from superheat was at once apparent, and, generally speaking, it may be said that all the large power houses and central stations which use steam turbines also use superheat. In these cases there is not only the thermal economy due to superheat, but it has been found that the dry steam has much less erosive action on the blades of the turbines than steam which is moist. An excellent article by Capt. C. A. Carr, U. S. N., published in the *Journal of* the American Society of Naval Engineers for February, 1911, gives a great deal of information with respect to these land plants, and will repay very careful study. Speaking generally, it is considered that with steam turbines of modern design and carrying from 175 to 200 pounds of steam pressure, there is a saving in steam consumption of about 1 per cent for each 10 degrees of superheat.

About ten years ago, Capt. Augustus B. Wolvin, then the manager of a number of steamboat lines on the Great Lakes, and who has been one of the pioneers in the adoption of improvements in marine machinery tending to economy, installed Babcock & Wilcox boilers and superheaters in one of the vessels under his control, and followed this by similar installations on several other vessels. One of these, the "James C. Wallace," was subjected to a test by a board of naval engineer officers, and showed a saving in coal of about 9 per cent, with an average superheat at the engine of about 85 degrees. The Bureau of Steam Engineering took up this subject, and in 1904 ordered Babcock & Wilcox boilers and superheaters to replace the old cylindrical boilers on the "Indiana." This was followed by installations of similar boilers and superheaters on the "Massachusetts" and the "New York" (now "Saratoga") in the way of replacements, and on the "Michigan," "South Carolina," "Prometheus," "Vestal," "Delaware," "North Dakota," "Texas" and "New York" (new), new vessels. In 1905 boilers and superheaters from the same makers were ordered for the steamship "Creole," with respect to whose performance some interesting data will be given later on. The Pennsylvania Railroad, in its marine service, has always shown a desire to get the safest and most efficient machinery, and in 1909 ordered from this concern boilers and superheaters for three of their large tugs, the "Johnstown," "Wilmington" and "Harrisburg," which have given great satisfaction and economy in service. The steam yacht "Idalia" also has a boiler and superheater supplied by this same firm.

It will thus be seen that superheat is in use on a large number of vessels, and undoubtedly a great deal of experience has been accumulated, but, unfortunately, not very much has been published.

Table I gives the performance of the steamship "Creole," which is fitted with Babcock & Wilcox boilers and superheaters, as compared with the performance of

* Reproduced from *International Marine Engineering.*

her two sister ships, the "Momus" and "Antilles," which have ordinary cylindrical boilers without superheat. As shown by the table, the hulls are practically identical. The "Creole" has twin screw engines of about 7,000 horse-power, while the "Momus" and "Antilles" have single screw engines of about 7,500 horse-power. All three ships carry about the same steam pressure—about 210 pounds. The "Creole" was originally fitted with Curtis turbines, but the speed was too low (15½ knots) to permit economical use and they were removed. It is to be noted that so far as there is any advantage in engine economy it should be with the "Momus" and "Antilles," which have each a single engine of about the same power as the aggregate of the two engines on the "Creole," thereby reducing the losses due to cylinder condensation. The engines are all triple expansion and of excellent design. The "Creole's" first trip with her new engines was made in the spring of 1910. Two comparisons are given, one of five round trips of the "Creole" in the summer of 1910, as compared with five round trips of each of the others, obtained by taking their best performances in the three summers of 1908, 1909 and 1910. The second comparison is between two round trips of all three vessels made in the month of October, 1910. They run over the same route from New York to New Orleans, and, as the hulls are identical and the engines designed and built by the same firm, the only material difference is in the boilers and superheat. The table shows that the "Creole" operates with about 17 per cent less fuel per round trip than her sister ships. The average superheat carried is about 60 degrees, from which a saving of about 6 per cent would be expected. It is to be noted however, that there is a distinct gain in economy due to the use of the Babcock & Wilcox boiler, as contrasted with the cylindrical or Scotch boiler.

In an article by the late Admiral George W. Melville U. S. N., published in the *Engineering Magazine* for January, 1912, are given reports of very accurate tests of Scotch boilers and of Babcock & Wilcox boilers, made by boards of navy officers and committees of independent engineers, so that the reliability of the data is beyond question. These tests showed that, at the rate of combustion obtaining in these vessels, the Babcock & Wilcox boiler shows an efficiency of about 74 per cent, as against from 62 to 67 per cent (average 64.5 per cent) for the Scotch boiler. Working out the saving due to this greater efficiency, it comes to 11.7 per cent, and this substracted from 17.45 per cent, the total saving, leaves 5.75 per cent as the saving due to superheat, which agrees quite well with the rough general rule of 1 per cent saving for each 10 degrees of superheat.

TABLE I.—ECONOMY DUE TO SUPERHEATED STEAM—MERCHANT VESSELS.

Name of vessel	Creole.	Momus and Antilles.
Date of tests	1910	1908-9-10
Length, feet	407	410
Beam, feet	53	53
Draft, feet	26.7	25.6
Tonnage, gross	6,754	6,878
Tonnage, net	4,302	4,329
Cylinders, diameter and stroke	(2) 27½, 40½, 42	(1) 34, 57, 104, 63
I. H. P.	7,000	7,500
Boiler pressure, pounds	210	210
Kind of boilers	Babcock & Wilcox, with superheaters.	Scotch, no superheater.
Ratio of superheating to evaporating surface, percent	1 to 15.5	.....
*Av. coal per trip for five round trips, tons	1,149	1,374
Percentage of saving by use of B. & W. boiler and superheater	†16.38	.....
Av. coal per trip for two round trips, each vessel, in October, 1910	1,206	1,461
Percentage of saving by use of B. & W. boiler and superheater	†17.45	.....

* The "Creole's trips were in summer of 1910; those of the other ships are their most economical trips in summers of 1908, '09 and '10.

† The improved economy is due partly to greater efficiency of boiler of "Creole" and partly to superheat. See text for analysis and discussion.

Table II gives the performance of four United States navy vessels, all of the same displacement and approximately the same power, and all fitted with Babcock & Wilcox boilers. The "Kansas" and the "New Hampshire" have no superheaters, while the "Michigan" and the "South Carolina" are fitted with superheaters. The performance of these four ships is very interesting, showing a saving, based on the average of the two ships, with superheaters as contrasted with the two without, of 18.52 per cent. In this connection it is interesting to note the remarks of Commander Henry C. Dinger, U. S. N., formerly editor of the *Journal of the American Society of Naval Engineers*, who wrote the account of the trial of the "South Carolina," and who says with respect to the better performance of the ships with superheaters:

"The engines of the "Michigan" and "South Carolina" represent a decided advance in economy of steam consumption of navy reciprocating engines. The design embodies the use of (1) superheated steam; (2) large ratio of cylinders, namely, $\frac{H.P.}{L.P.} = \frac{1}{10}$, and (3) a considerable reduction of cylinder clearance. Calculations from indicator cards indicate that the steam consumption at full power was about 12.6 pounds of water per indicated horse-power. This result may be considered as being within a few per cent of the actual consumption. This shows a gain of about 16 per cent over previous navy practice; of this gain one half may be assigned to the use of superheated steam, and the other due to reduction of clearance and better cylinder proportions."

In October, 1909, a test was made of the machinery of the yacht "Idalia" with superheated steam by Dr. D. S. Jacobus, and witnessed and reported by Lieut. John Halligan, Jr., U. S. N. The owner of the "Idalia" is an accomplished engineer, which insures the maintenance of the machinery in first-class condition at all times. She has a four-cylinder triple-expansion engine, the cylinder diameters being 11.5 inches, 19 inches, (2) 22.7 inches by 18 inches stroke. All the cylinders are unjacketed and have piston valves. There is one Babcock & Wilcox boiler, with 65 square feet of grate surface and 2,500 square feet of evaporating surface and 340 square feet of superheating surface. These tests are notable from the fact that the weight of the steam used was carefully determined by weighing the steam condensed in tanks on carefully standardized platform scales. The actual duration of the test in each case was about 2½ to 3 hours, but observations were made every 15 minutes. The well-known reputation of Dr. Jacobus as an experimenter insures the accuracy of the results, which are given in Table III. The duration of the experiments was obviously too short to make it worth while to attempt to measure the coal. It is to be noted that the feed, air and circulating pumps, all of which are independent, discharge their exhaust steam into the main condenser, so that the figures given for steam per horse-power include the steam used by these auxiliaries, as well as by the main engine, while the horse-power is of the main engine only. This is mentioned in order that the results, which might otherwise be considered rather high, may be thoroughly understood.

We have now given such experimental data as are available of measurements of coal and water to show the economy of superheating, and, as stated above, they bear out the rough rule that there is about 1 per cent in saving of fuel for each 10 degrees of superheat.

The practical effect of superheated steam is, of course, to give a greater thermal efficiency to the engine in which it is used and reduce the number of pounds of steam required per horse-power. The question has frequently been raised whether there is a corresponding saving in fuel. That is, will not the fact that a pound of superheated steam contains more thermal units than a pound of saturated steam require in the long run a greater expenditure of fuel per pound of steam, so that, although fewer pounds of steam are used per horse-power, it takes a greater amount of coal for a given number of pounds of water evaporated? Speaking generally, it may be asserted that with superheaters properly designed and located, and within the limit of superheat ordinarily used in marine practice—50 to 100 degrees—such tests as have been made, and such general experience as has been gained, tend to show that there is in the long run practically no increase in the fuel per pound of steam, or, in other words, there would be almost exactly the same percentage of reduction in the amount of fuel used as in the amount of steam per horse-power. It is not difficult to understand why this should be the case in a properly designed arrangement of superheaters. In all the cases cited, and these are the only ones for which data are available, the superheaters are used with Babcock & Wilcox boilers. As is well known, a system of baffling is used in these boilers which causes the hot gases to cross the tubes three times on their way from the furnace to the up-take. The superheaters are placed at the passage from the first to the second pass, after the gases have crossed the tubes once before they cross the second time, so that the temperature is very much higher than in the case of the older types of superheaters, where they were placed in the up-take like a feed-water heater. The experiments which have been made on these boilers under various rates of combustion show that the temperatures where the superheater is located, when burning from 30 to 35 pounds of coal per square feet of grate, would be about 1,000 deg. Fahr., while the temperature of saturated steam of about 200 pounds is about 388 deg. Fahr. There is thus a good difference in temperature, so that a considerable degree of superheat is obtained with a moderate amount of superheating surface. There are still the second and third passes of the boiler to be acted upon by the hot gases, and the only effect is to reduce slightly the temperature of the gases in the up-take. Hence the efficiency of boiler and superheater is at least as great as that of the boiler alone.

The examples we have given of the navy vessels, of the "Creole" and her sister ships, and the "Wallace," with and without superheat, all show results as measured in coal, while the "Idalia" experiments give them in water. None of these experiments has the conditions absolutely ideal for determining with extreme accuracy the exact amount of gain due to superheating, because other items vary besides the extent of superheat. What practical men desire to know, however, is not results to the last decimal point, but to be reasonably sure that there is a decided gain due to superheating and this has, from the data given, been shown beyond question.

We have already mentioned one of the benefits which has been found in land service where superheated steam is used with turbines, and, obviously, thoroughly dry steam, as against very moist, would be a blessing in reciprocating engines, so that this, of course, is another benefit of superheating. On board ship, where there are so many auxiliary engines scattered over a large area, and many of them simple cylinders following full stroke, it can readily be seen that the use of superheated steam ought to be conducive to a great increase of economy. Unfortunately, if tests of this kind have ever been made by the Navy Department they have not been published.

It now remains to mention some of the drawbacks, or rather matters which have to be attended to, if the use of superheated steam is to be entirely satisfactory. In the central stations and power houses on shore, before the use of superheated steam, many of the valves and fittings in the pipe lines were of cast iron. It was found that superheat of 100 degrees, or higher, caused considerable trouble, due to distortion of the cast iron fittings and inability to keep the valves tight. The general practice now is to avoid the use of brass or cast iron, and the valve bodies and fittings which come in contact with superheated steam are to be of cast steel. Valve seats are made of bronze with a large percentage of nickel or of Monel metal, which is a natural bronze of somewhat similar composition. The navy is now using Monel metal valves and seats. With these precautions, experience has shown that superheated steam up to 100 degrees can be used with great satisfaction as far as practical service is concerned, with no increased cost of repairs and with decided increase in efficiency.

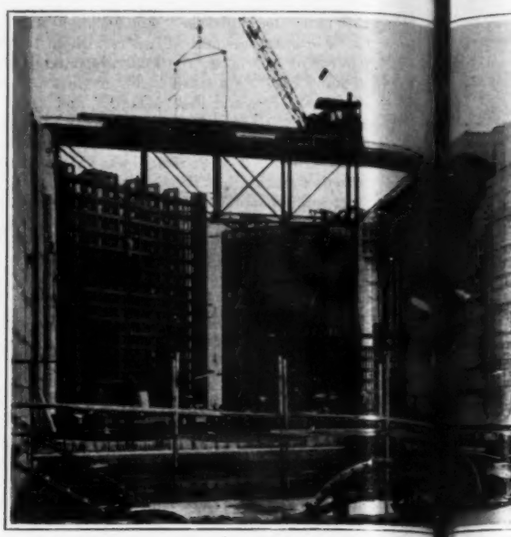
TABLE II.—ECONOMY DUE TO SUPERHEATED STEAM. OFFICIAL TRIALS OF UNITED STATES NAVAL VESSELS.

Name of Vessel	Kansas.	New Hampshire.	Michigan.	South Carolina.
Builders	New York Shipbuilding Co.	New York Shipbuilding Co.	New York Shipbuilding Co.	Wm. Cramp & Son S. & E. B. Co.
Date of trial	Dec. 14, 1906.	Dec. 20, 1907.	June 10, 1909.	August 25, 1909.
Displacement on trial, tons	16,000	16,145	16,064	16,064
Twin screw engines, diameter and stroke of cylinders, inches	32½, 53, (2) 61; 48	32½, 53, (2) 61; 48	32, 52, (2) 72; 48	32, 52, (2) 72; 48
Kind of boilers	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.	Babcock & Wilcox.
Evaporating surface in use, square feet	52,752	47,112	42,432	42,432
Superheating surface in use, square feet	No superheaters.	No superheaters.	5,174	5,174
Ratio superheating to evaporating surface, per cent	.....	.....	12.2	12.2
Heating surface, total square feet	52,752	47,112	47,606	47,606
Grate surface, total square feet	1,097	1,100	1,046	1,046
Ratio evaporating to grate surface	* 48.0 to 1	42.81 to 1	40.6 to 1	40.6 to 1
Speed, average for trial (4 hours)	18.004	18.162	18.79	18.86
Revolutions, average per minute (4 hours)	121.32	118.75	119.46	121.28
Steam pressure at boilers, gage, pounds	278.2	246.00	297.70	285.00
Steam pressure at high-pressure steam chest, gage pounds	250.0	222.00	246.00	241.00
Steam pressure, first receiver, absolute, pounds	106.5	93.00	77.40	96.50
Steam pressure, second receiver, absolute, pounds	38.0	32.20	8.10	35.10
Vacuum in condensers, inches of mercury	28.0	25.60	27.00	26.2
Superheat at high-pressure chest, degrees Fahrenheit	None.	None.	85.70	47.5
I. H. P. of main engines only	19,302.00	16,772.00	16,016.45	17,651.00
I. H. P. of all auxiliaries in use	455.00	495.00	500.85	706.00
I. H. P. total	19,757.00	17,267.00	16,517.30	18,357.00
Coal per hour per I. H. P. of main engines	1.779	1.785	1.51	1.395
Coal per hour per I. H. P. of main engines and all auxiliaries	1.737	1.773	1.46	1.341
Coal per hour per square foot grate surface	31.21	27.21	23.28	23.47
Air pressure in fire rooms, inches of water	0.60	0.49	0.67	0.78

TABLE III.—ECONOMY OF SUPERHEATED STEAM. TESTS ON YACHT IDALIA. SUMMARY OF TESTS.

Date, 1909.	Conditions.	Pressures. Throttle.	First Receiver.	Second Receiver.	Vacuum.	Temperatures. Feed.	Hotwell.	R. P. M. Air Pump.	Circulating Pump.	Revolutions per Minute, Main Engine.	I. H. P., Main Engine.	Water per Hour, Total.	Water per I. H. P.	Per-cent Saving of Steam.
Oct. 11	Saturated.	190	68.4	9.7	25.5	201	116.0	57	196	194.3	512.3	9,397	18.3	
Oct. 14	Superheat, 57°	198	68.0	9.2	25.9	206	109.5	56	198	1 1.5	495.2	8,430	17.0	. 7 10
Oct. 14	Superheat, 88°	201	64.3	8.7	25.9	205	115.0	53	196	195.1	521.1	8,234	15.8	13 66
Oct. 12	Superheat, 96°	198	61.9	7.8	25.4	202	111.5	54	195	191.5	498.3	7,902	15.8	13.66
Oct. 13	Superheat, 105°	203	63.0	8.4	25.3	200	111.0	45	197	193.1	502.2	7,790	15.5	15.30

Slide of Stratified Rock, West Bank of Canal. This Slide Involved About 900,000 Cubic Yards and Moved About 5 feet per Day on a Slope of One in Seven.



Pedro Miguel Locks, South End of East Chamber

Bird's Eye View of Gatun Locks, Showing Ships Being Towed Through by Electric Locomotives.

We present a series of illustrations of the work at Panama, which show the advanced stage to which the various parts of the canal have been carried, and incidentally serve to explain the confidence of the engineers that they will be able to send the first ship from ocean to ocean in about twelve months from this port. As matters now stand the work of concreting is very nearly completed. Over 93 per cent of the concrete for the locks being now in place, the total yardage laid being 4,070,166 cubic yards, out of a total of approximately 4,362,563 cubic yards. At the great Culebra cut through the divide, had it not been for the great number and size of the slides which had developed during the work of construction, the excavation would have been finished on January 1st of the present year. As it is, some seven to eight million yards have yet to be removed, about one half of this material consisting of slides which are already in motion or are likely to develop. The engineers have no apprehension that further developments of slides will hinder the opening of the canal, for when the water has been allowed to rise in Gatun Lake to the full height of eighty-five feet above sea level, any further material that may slide into this canal, will be taken out by suction dredges, loaded in barges, and towed out to sea; this method will not interfere with traffic and will cost less than the present system of using steam shovel and dirt train.

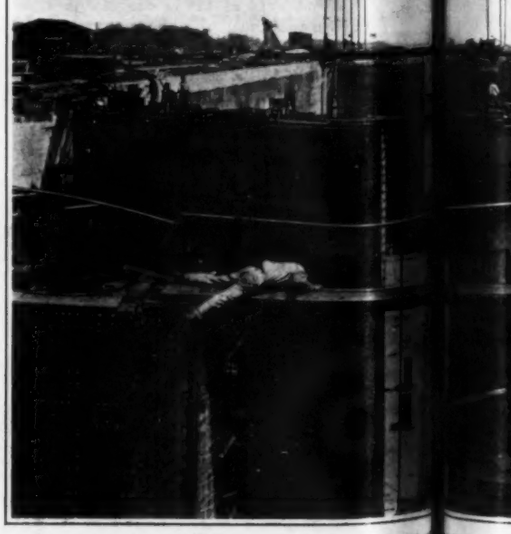
Completing the Pana

A Brief Account of the Greates

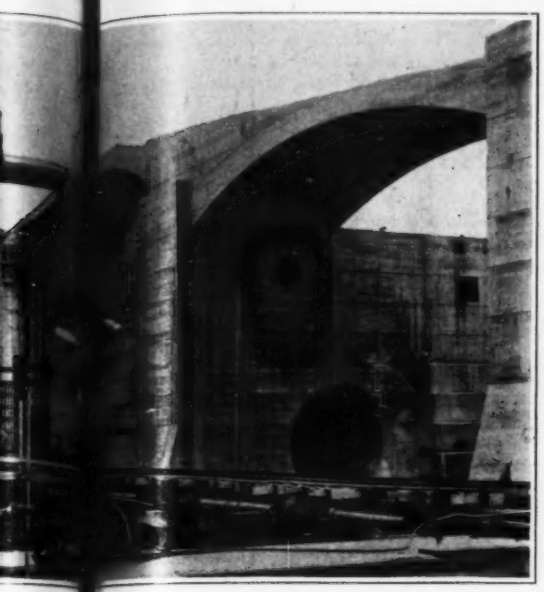
The present time is opportune for giving a résumé of the task which is now so near its close; and perhaps we cannot do this better than by outlining the course to be followed by the leading ships of the fleet which will pass through the canal on the great day of opening, January 1st, 1915.

The first evidence of American work at Panama will present itself, as we enter Colon Harbor, in the form of a massive breakwater, over two miles in length, which extends from Toro Point at the Westerly side of Limon Bay. Rounding the breakwater, which by the way, has been built to protect shipping in the bay against the heavy northeasters, we shall enter a channel, 500 feet in width and 41 feet deep, which has been dredged from deep water to the shore line, a distance of about four and one half miles. Leaving Colon on the left, our ship will steam on a straight course through a comparatively low-lying land from the shore to the entrance of the Canal Locks at Gatun. This section of the canal will be also 500 feet in width and 41 feet deep, and here we pass through the slight divide, known as the Mindi Hills, on the further side of which is the valley of the Chagres River. At this point the valley narrows down to a width of about a mile and a half and to our right we note the long straight skyline of the crest of a vast artificial hill, 115 feet in height, which has been built laboriously from

Culebra Cut, Empire, Looking North from West Bank at Cunette. The Two Shovels in the Foreground are Working on the Final Bottom of the Canal. Elevation, 40 feet.



Gatun Upper Locks, West Chamber, Looking Nor of Gates.



g Construction of Safety and Lower Gates.

Relocation of Panama Railroad. The Brazos Bottom, Looking North. June, 1912. Note the Heavy Filling on Each Side the Track, to Balance Earth Movement.

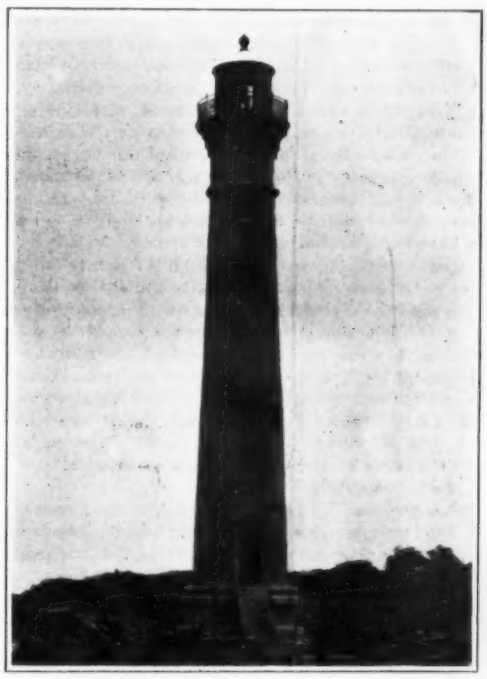
anama Canal

gineering Work of All Time

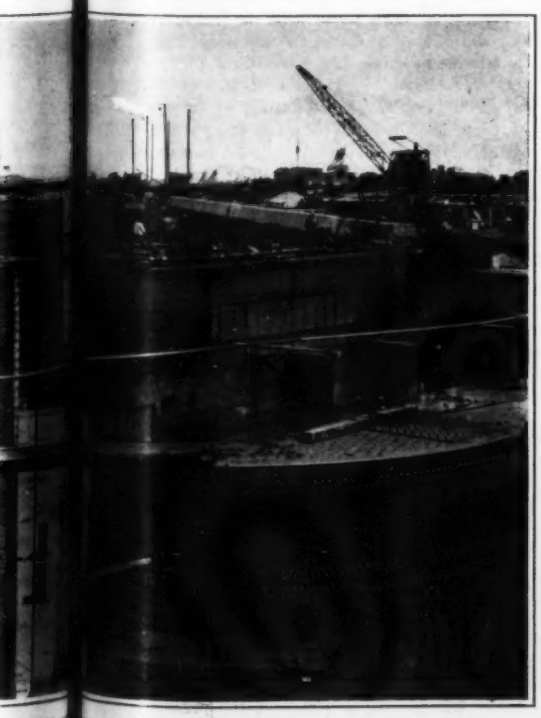
one side of the valley to the other and is known as the Gatun Dam. At the center of this dam we see the Spillway, with the surplus waters of the lake flowing through its gates and passing down through the wide Spillway channel to discharge into the old bed of the Chagres River. Immediately in front of us is the 4,000 foot-stretch of the Gatun Locks, each 1,000 feet long, 110 feet wide in the clear, and having a lift of 28 1/3 feet. We enter the right-hand lock, and the gates having closed behind us, we are lifted 28 1/3 feet, the process being repeated until finally the upper gates are swung open and we enter the broad waters of Gatun Lake. Our progress through the locks was not made under our own steam; instead, four electric-towing locomotives, running on the side and center walls were made fast to our ship, two at the bow and two on either quarter, and all movements, until we reached the lake level, where made under their exact control, at a speed of about two miles per hour.

Gatun Lake has been formed by the dam before mentioned and when it stands at its normal level of 85 feet, the lake has a surface area of about 170 square miles. As soon as the towing locomotives have cast off, we proceed under our own steam, and soon are moving at full speed through a channel dredged in the bottom of the lake, which is 1,000 feet in width for the first sixteen miles of our course. Then the channel narrows to 800 feet for about two and one half miles, 700 feet for the next mile, and 500 feet for the following three miles, which brings us to the great cut through the Culebra divide. Here the channel narrows to its smallest width of 300 feet, which it holds for a distance of nine miles through the Culebra Cut, or until the two-flight lock at Pedro-Migul is reached. Here we drop from elevation 85 to 55, and after steaming for about a mile and a half through a small artificial lake, impounded by a dam at Miraflores, we reach the locks of the same name which drop, in a single reach the locks of the same name which drop us, in a single flight. down to sea level on the Pacific side. About eight miles of steaming through the sea-level channel brings us to deep water on the Pacific side.

Only those who may have been so fortunate as to traverse the canal before it was water-filled, will have an adequate conception of the magnitude of the task. A pictorial representation of the quantities of excavated material and concrete was given on page 391 of the SCIENTIFIC AMERICAN Canal Number of November 9th, to which attention is directed. From this we learn that the excavated material would build a line of 63 pyramids of the size of the Great Pyramid which, if they were placed in line, would extend for a distance of nine miles. The work of excavation would dig a canal 55 feet wide, 10 feet deep, entirely across the United States.



An Aid to Navigation. Front Tower of Range 5-6, Atlantic Section. Height, 74 feet. July 14th, 1912.



South End, Showing Construction of Three Sets 1912.

Gatun Locks, General View, Looking Southwest, Showing North End of Locks with Temporary Coffer-dam in place. June, 1912.

Nature as a Physician*

The Blunders She Makes in Her Efforts to Cure

By Augustus Maverick, M.D., San Antonio, Texas

It was Voltaire who made the remark that "the physician amuses the patient while nature cures the disease." Unfortunately there has always been much that is true in this aphorism, but if the author of the "Age of Louis XIV" could return to-day with a gangrenous appendix or a plaque muquese he would have to confess that the physician is becoming as useful as he is amusing. As a matter of fact, the physician has always owed his livelihood to nature's inability to care for the sick. If nature were famed for its skill at relieving pain, draining abscesses and killing invading parasites, the physician would starve to death; but judging by the stream of newborn healers which pours from our colleges as fast as the printers can turn out the diplomas, nature leaves a large field for improvement. There is still a lot of talk of adhering strictly to natural methods in the treatment of disease, but those who talk the loudest must confess that in severe diseases where we "leave nature to take its course" the outlook for the patient is always the worst. To turn a very ill person over to nature is like sending a dying consumptive to Egypt. Compare the breathless victim of pneumonia or the stuporous typhoid patient, untouched by cold water, awaiting the verdict of the unknown, to the surgical case of gallstones or the prey of the anopheles well dosed with quinine. Is nature's treatment for pain, by causing the sufferer to faint from exhaustion, better than the physician's hypo of morphia, or is nature's effort to squeeze a kidney stone through sixteen inches of tubing, one-fourth its diameter, preferable to ether, antisepsis and the knife? It is common to hear a drug or system of treatment recommended because "it is nature's own remedy." Would it not be better to say that it is *our* own remedy and twice as good as anything nature has to offer? Would this be blasphemous to a system of government which puts us on earth to fight unceasingly for our life? It is the surgeon who to-day is leaving the least to nature and doing the most for his patient; it is the internist who lags behind in his treatment under the delusion that what is natural is best and is making nature his guide rather than experiment.

Inflammation and Scar Tissue.—Not long ago an Eastern surgeon in suturing a wound of the intestines left the lumen too small and chronic intestinal obstruction resulted. The surgeon suffered severely in the hands of local gossips, for the most inexperienced holder of a medical diploma was expected to know how to sew a gut and still leave it open. Yet, this trick is performed every day by nature in healing dysenteric and other ulcers of the bowel; the wound is bound with scar tissue which shrinks with age and finally strangles the gut it came to heal. Scar tissue is nature's cureall for wounds. When a cut is made through the skin the edges are brought together by a delicate net-work of scar tissue threads and so neatly is the work done that in time only a seam is left to mark the once unsightly deformity. This scar at first is pink from a rich supply of capillary vessels, but as scar tissue grows older its nature to contract and squeeze, shut the vessels which give it life; so that in time a white, tough, puckered scar remains. All this is of no great consequence on the skin, except for a possible distorted face or crippled hand, but it plays havoc within the body where the structures are more delicate. Take the heart valve which is left ulcerated by an attack of endocarditis; the inevitable scar tissue starts its patchwork and makes a neat job of covering over the denuded areas, but instead of leaving well enough alone it goes on contracting and in time a useless, puckered bunch of valve leaflets remains, the heart works in vain to overcome the backflow of blood and the days of the victim are numbered. Among numerous other examples of serious results from scar tissue may be mentioned strictures of the pyloris, rectum and urethra; deformed joints; cirrhosis of the liver; Jacksonian epilepsy; chronic Bright's disease, and arteriosclerosis. Even with a strictured pylorus the victim manages to find some enjoyment in life, but this is not all that is sometimes in store for him; only too often the scar tissue sets up such an irritation of its own that cancer takes root as the result. That this is frequently the final stage in nature's long drawn-out effort to heal an ulcer of the stomach, a torn cervix uteri, or a scarred gall-bladder is unfortunately common knowledge. No quack ever handed his patient a worse deal than this. In old age the organs have become so riddled with this weedy substance, scar tissue, that life is squeezed from the body many years before the proper time. Suppose we had a scar tissue which, after it had performed its duty, stayed pink and soft and never shrank—what an ideal remedy this would be!

Acute inflammation is also a fair example of the crude way disease is often handled by nature. All the swelling, pain, and discomfort of an infected area is not due to the invading germ but to the natural remedy. Of course we should be grateful for any protection at all from foreign irritants, but we must confess that this process is frequently rather far fetched. Does not the swelling about the glottis, which cuts off the air from the little chap, the victim of croup, seem a rather drastic treatment for a slight irritation of the larynx, and is not this also true for the infant who cannot suckle because nature is treating a slight cold in the head, and again, the patient who is dyed a deep yellow because the bile ducts are swollen shut from a catarrh which otherwise would pass unnoticed? When inflammation goes on to suppuration and an abscess forms it is certainly time for us to interfere; left to itself the abscess may, after a long and torturing interval, dry up and leave adhesions tugging on neighboring structures, or it may, with agonizing pain to the patient, point and drive its deadly contents straight into the peritoneum or some other vital field. Who is there to-day with an abscess of the appendix who will place himself in nature's hands when a surgeon is nearby?

The tendency of different mineral salts from the body juices to collect about irritating foci is often applauded, and well so, for it is in this way that a tuberculous area is imprisoned. However, there are times when this process does more harm than good. Take a mass of typhoid bacilli which is providing a nuisance within the gall-bladder; nature turns loose an abundance of bile salts which deposit about groups of bacilli to form thick shells. Are the bacilli walled off and made harmless by this method? Yes, but there are left ten to a hundred or more gallstones which play the very devil with the unlucky owner.

Overdosing.—We have learned by experience that moderation in treating disease is as important as moderation in everything else, and that the most harmless remedies become poisons in overdoses. Nature often gives overdoses, and thereby does more harm than good. Fever is a good example. Fever is now recognized as nature's attempt to make the blood too hot for the comfort of invading microbes. A moderate amount of fever evidently aids the patient, but when it becomes excessive the question arises: which is causing the most damage, the bacterial toxins or the heat? The headache, anorexia, malaise, rapid heart, hurried breathing, scanty kidney elimination, nervousness, delirium, stupor, cloudy swelling and the whole train of symptoms of the acute infections—how many are caused by the disease, the toxins, and how many by the natural remedy, the fever? The benefit derived from the use of plain cold water in typhoid fever will help to answer this question. Another example of a natural remedy carried to excess is the hypertrophied heart. When imperfect closure of the valves demands more work of the heart its muscular walls thicken to supply the extra power. If this method made up for the deficiency and kept step with an ever-increasing deficiency, well and good, but it does not. The heart goes on enlarging and pounding away far beyond the demand made upon it and the patient relieved of some little tendency to dropsy or shortness of breath now suffers more distressing symptoms. If this ability to increase in size were unlimited the natural treatment of heart disease might remain merely troublesome and not prove dangerous, but there comes a time when the growing muscle cannot receive enough blood to nourish it; it is the old cry of no food, no work, and the heart, unable to keep up the pace it has set, fails and fails rapidly. Here is an example of how a little prudence on the part of nature could keep the heart active many years after it has ceased to beat, for it is not nature, but the physician who, with his drops of aconite, prolongs the patient's life, or, at a later date, with his digitalis, keeps beating the heart long since thrown aside by its maker. A high blood-pressure is commonly a bad natural therapeutic measure. In attempting to compensate for what the failing heart and kidneys refuse to do, the pressure in the vessels rises often above 200 millimeters of mercury. Any minute such a man may drop unconscious from apoplexy unless the physician with his nitrites can undo some of the mischief by bringing the pressure down. A cough, as we know, is nature's method of blowing irritating matter from the bronchi. We can all recall instances of how this is frequently carried too far. There is, for example, no sense in making a child cough until it vomits or breaks a sub-conjunctival blood vessel, for all the good it does in whooping cough. The congestion of the mucous membrane of the larynx and its injury by being brought into violent contact following a severe paroxysm of coughing, surely does more harm than good. The cough of phthisis is certainly an unwise prescription when it keeps the patient sleepless and nervous or encourages hemorrhage or the dissemination of infection. Diarrhea, which persists after the bowel is as clean as a gun barrel, the profuse nasal flow from a single cold, the edema which closes the glottis, the bony callus which entangles the nerve—these are but few of the many other examples of how nature overdoses its patients.

Antibacterial Properties of the Blood.—Much is heard today of the wonderful natural properties of the blood to kill invading bacteria and neutralize their toxins and of our ability to aid nature in the use of these. When we add antitoxins or bactericidal products to the blood, we are merely imitating nature, not doing something better. Of course, in adding, for example, diphtheria antitoxin to the blood in large quantities and thereby saving an urgent case of diphtheria, we are doing something which in the time allowed nature could never have accomplished, but, nevertheless, the method employed is purely nature's. Armed with antitoxins, antibacterial sera, and preventive vaccines, our task of fighting infectious diseases will be lightened for some time to come. It is not these, however, but chemical compounds like salvarsan, selenium with eosine and mercuric succinimide, purely the work of man, which will constitute the ultimate goal of therapeutics. Suppose the blood had naturally a *therapia sterilisans magna*, instead of all these million and one different antitoxins, opsonins, agglutinins, precipitins, bacteriolysins, and other unchristened agents—what a remedy this would be! One trouble about these antibodies is that they are too complicated and have to be manufactured by the body cells separately for each disease, and this the cells often cannot do; we can readily understand how the cells may find it difficult to manufacture the different complicated side chains to fit the corresponding links of each separate germ. Another fault is that being biological products manufactured by living cells and the bacteria which they attack also being living cells, the bacteria are able to make similar antibodies of their own. Thus we have the reciprocal antibodies, or so-called aggressins of the invading parasite being prepared to neutralize the antibodies of the blood; while in the case of a chemical compound the germ would be unable to manufacture an antidote so readily. The recognition of a hypersensitiveness or an anaphylaxis which the body may develop for a substance, comes as a warning to the unreliability of some of nature's methods in this direction. How are we to know on administrating a remedy, especially a foreign blood serium, whether the patient can stand a double amount the next time or has developed such a hypersensitiveness to it that another similar dose will kill him? We were led to believe that nature could develop enormous powers of resistance to any poison administered in increasing doses; what are we to think now of this dangerous reversion? How do we know now whether nature does not possibly at times make us hypersensitive to the secretions of our own body cells and allow this rebellion of the tissues to cause all kinds of disagreeable idiopathic symptoms?

Where Compensation Fails.—We often admire the way in which one kidney does the work of two when the second is removed and how a small portion of lung will carry on the work of a wide-spread area destroyed by tuberculosis. This natural compensatory action, however, is by no means constant. In injuries to the eyeball we are familiar with the danger of sympathetic inflammation of the healthy eye. Sometimes, in fact, the opthalmic surgeon can make of the injured eye a more useful one than the other, the victim of natural interference. In treating a wound involving a main artery of the leg or arm, nature calls various anastomosing arteries into service to form a circuit around the break in the blood stream and to allow the circulation to proceed unimpeded. This is a wise provision and means the saving of a limb which at the present time the surgeon would have to sacrifice. Why, may we ask, does nature not have these anastomosing arter-

* Reproduced from the *Medical Record*.

less instead of the so-called end arteries in vital organs so much more important than the limbs? If the dorsal artery of the thumb becomes plugged or divided, anastomosis with the *princeps pollicis* on the other side prevents this finger from suffering any loss of blood supply; on the other hand, if one of the ganglionic branches of the middle cerebral artery becomes plugged, nature is unable to do for the brain what it did for the thumb and apoplexy with death or worse is the result. The most vital spot of the brain is thus laid bare to a bit of natural negligence which even the smallest toe does not suffer. During starvation the different ways in which the body metabolism economizes the food supply is often remarkable. Nevertheless, in a starving child, nature will allow the food to be used for the growth of the skeleton before supplying the vital organs dying of hunger, and the bones ignorant of the greed grow longer up to the very point of death.

The Conquest of the Air by the Chemist*

Oxidation of Atmospheric Nitrogen and the Development of the Resulting Industries of Norway

UNDOUBTEDLY one of the most interesting features of the late International Congress of Applied Chemistry was the address by Dr. Samuel Eyde, who is not only one of the joint inventors of the Birkeland-Eyde process, but who has been able to promote the industry of the fixation of atmospheric nitrogen within ten years in such a way that it is now the biggest and most marvelous new industry of Norway. After explaining that the atmosphere surrounding us is composed of oxygen and nitrogen and that the task of the new industry is to create by the union of the oxygen and nitrogen gases new chemical combinations which can be utilized in the world's household, he referred to the pioneer work of Priestley and Cavendish, of Sir William Crookes and Lord Rayleigh, and of Bradley and Lovejoy at Niagara Falls.

The difference between these previous methods and those of the Birkeland-Eyde process is that the latter employ large quantities of electric energy in the electric arc and have first found out the best method of doing this, while it was previously believed that it was small quantities of energy that gave the best results.

Dr. Eyde described the principle of the Birkeland-Eyde process, which as our readers know, is to drive the air through a flame disk produced by electromagnetic deviations of an electric arc.

With the commercial furnace which they have developed they have been able to reduce the whole operation to such a routine practice that the furnace burns for weeks without any regulation worth mentioning. The maintenance of the furnace and its repairs are simple, as the most exposed portions, the electrodes, only require to be changed every third or fourth week, and then only a small part of them, and the fireproof masonry every fourth to sixth month.

The temperature of their flames exceeds 2,500 deg. or 3,000 deg. C. The temperature of the escaping gases may vary between 800 deg. and 1,000 deg. during ordinary working. The furnaces are made of cast steel and iron, the middle of the furnace being built out to a circular flame chamber. The electrodes are led radially into this flame chamber. By aid of centrifugal fans the air is brought into each furnace through tubes from the basement.

The experimental work of Birkeland and Eyde started with a furnace not larger than could be held in a hand, and now they have succeeded in building furnaces which consume more than 5,000 horse-power and from absorption apparatus on a laboratory scale with a few liters capacity they have passed over now to absorption towers of granite with a capacity of 600 cubic meters or 600,000 liters each.

Dr. Eyde then discussed the Schoenherr furnace. In this furnace the air passes in a spiral path around a very long drawn-out arc upward, the furnace being of a long tube form. Dr. Eyde remarked that the reaction in the Schoenherr furnace is identical with that obtained in the Birkeland-Eyde furnace and the yield as far as the results now obtained shows practically the same.

Dr. Eyde stated that at Notodden they have only furnaces of the Birkeland-Eyde system from 1,000 kilowatts to 3,000 kilowatts. At Rjukan there are, however, furnaces of the Birkeland-Eyde system of 3,000 kilowatts as well as furnaces of Schoenherr's system all of 1,000 kilowatts.

The operation aside from the electric furnace was described by Dr. Eyde as follows: The air for the furnaces is procured by swiftly revolving fans. The air is conducted through large iron pipe lines to the furnaces. When the air in the flame chamber has been treated by the electric flames, the nitrous gases formed pass out through a channel to two fireproof lined gas-collecting pipes, which convey the gas through the basement to the steam boilers in which the temperature is reduced from 1,000 deg. C.

The steam produced in the boilers is utilized in the further treatment of the products. In the boiler house there are also two large and two small air compressors, which supply compressed air for pumping acids and lye in the factory's various departments.

The gases pass on from the steam boilers through an iron pipe into the cooling house, with the object of completing the cooling commenced in the steam boilers. This cooling is necessary in order to obtain a suitable absorption. Each cooler consists of a great number of aluminium tubes, over which cold water runs, while the hot gases pass through them. The temperature of the gas is considerably reduced. From the coolers the gases go on to the oxidation tanks.

These oxidation tanks are vertical iron cylinders, lined with acid-proof stone. The object is to give the cooled gases a sufficient period of repose in which the oxidation of the oxide of nitrogen may have time to take place. The necessary amount of oxygen is present in ample quantity in the air which accompanies the gases from the furnaces. From the oxidation tanks the gases are forced by blast engines into the absorbers.

ABSORPTION TOWERS.

All the towers are filled with broken quartz, which is neither affected by nitrous gases nor by nitric acid. To assist the passage of the gases on their way from the furnaces there are centrifugal fans, constructed of aluminium on each row of towers.

The gases enter at the basis of the first tower, go up through the quartz packing and thence by a large earthenware pipe enter the top of another tower through which they pass downward through the quartz to the bottom of the third tower, and so on, until the air, relieved of all nitrous gases, leaves the last tower. Water trickles through the granite towers and this is gradually converted into a weak nitric acid, while the liquid used in the iron towers is a solution of soda.

The absorbing liquid enters the top of the tower and is distributed in jets by a series of earthenware pipes, so that the permeating gases come in immediate contact with the absorbing liquid. In the granite towers nitric acid is thus formed and in the iron towers a solution of nitrate of soda.

The liquid emerges in a constant even stream from the bottom of the towers, that from the granite towers running into a granite cistern. Hence it flows into the montejus which serve to pump up the acid, which has to pass repeatedly through the tower before it has become strong enough for the purpose for which it is intended. The montejus are of stoneware strengthened with iron shields, are worked by compressed air and send the acid up into large stoneware jars. From these jars the acid again runs through the towers as described. The montejus work automatically.

The iron towers are percolated, as already mentioned, by a solution of soda, otherwise the whole process is practically similar to that in the granite towers. The solution of soda, owing to its far greater power of absorption, effects the separation of the last remains of nitrogenous gases from the accompanying air. Of the entire quantity of nitrous gases passed through the absorption system about 97 per cent is absorbed.

SOLUTION WORKS.

The finished nitric acid coming from the towers, which has a strength of about 30 per cent by volume, is collected in granite cisterns, from which it is drawn to what is called the solution works. These consist of granite vats filled with limestone over which the acid is poured. This drives off, with violent effervescence, the carbonic acid contained in the limestone, while the nitric acid takes its place and forms a watery solution of nitrate of lime or calcium nitrate.

The rest of the acid is neutralized in small towers filled with milk of lime and is now pumped into vacuum evaporating apparatus. The object in boiling in vacuum is the well-known fact that great saving is thereby effected in the heat required.

The steam required from the evaporization is obtained from the steam boilers, heated, as before mentioned, by furnace gases. The concentration of the nitrate solution in the evaporizing plant is continued until the specific weight of the liquid at a given temperature shows a content of 13 per cent of nitrogen.

This solution is then sufficiently evaporated and can be pumped up into the solidification chambers, where it is conducted upon a revolving cylinder, cooled on the inside, where it stiffens so quickly that it easily can be brought to spring off into small leaf-similar pieces, which without difficulty can be granulated in the crushing mill, where the mass is reduced to a granular state.

The coarse powder so produced is raised by elevator to a vat, from the bottom of which it is tapped into casks holding 100 kilograms net weight. The gas led into the iron tower forms with the solution of caustic soda a solution of nearly pure sodium nitrate. This is concentrated by evaporation in the same sort of apparatus as above and allowed to crystallize. The crystals are dried in a certrifuge and tapped into casks. The barrels are made at the factory's own cooper's shop and are lined with paper to guard against damp. Besides these two products, nitrate of lime and nitrate of soda, they have during the last year at the Notodden Works taken up the manufacture of nitrate of ammonia, which product already has won a good reputation, and in comparatively large quantities is shipped to the United States.

THE IMPORTANCE OF WATER POWER.

In this industry the water power is all important. The works now being built are all situated in the southeastern part of Norway and the Telemark River. The first work, the Notodden nitrate factories are admirably situated at the lake of Hiterdal, about 50 feet above the level. A short channel with a series of locks permits communication with the town Skien, an important seaport at the head of the fjord. Under the present conditions vessels of 200 tons burden can ascend to Notodden. It is planned to enlarge the locks so as to allow the passage of seagoing vessels of 2,000 tons. This ability to ship directly to all parts of the world by water is an important factor in the future of the Notodden nitrate industry.

The Notodden factories, which now have about 60,000 horse-power in working, get this power from two neighboring waterfalls, Lienfos and Svaelgfos.

The equipment of the hydro-electric plants was described by Dr. Eyde in some detail. For transportation it was necessary to build railways and provide ferryboats, and the end of the development has not yet been reached. At the Rjukan waterfalls it is intended to build two power stations which will furnish the factories with 250,000 horse-power.

Dr. Eyde illustrated brilliantly the development of his industry by lantern slides showing the factories at different times. In the beginning a few farmers were at the spot. Now there are towns with all the comforts of modern civilization.

According to the results of the use of their nitrate of lime, it is stated, that the use is the same as the Chile salpeter, and for certain soils it is even better. Now they are sending many thousands of tons of Norgersalpeter to California and Hawaii to be applied in fruit orchards and sugar plantations; and the demand this year has been twice as large as last year.

The conclusion of Dr. Eyde's speech is perhaps more characteristic of the man than anything else. He spoke as follows:

"If you ask me what above all has contributed to such a rapid development of an industry, then I wish to mention the confidence the financial people gave me and the good collaboration between me and my engineers. We all were filled with the same thought, to create something great and useful for our country, and we all had in view the great importance this new industry would have from an international standpoint.

YOUNG MEN FOR PIONEER WORK.

"There is, however, one thing which I wish to tell you and which more than anything else has contributed to the great success obtained in the development in this industry, and that is that I mainly have employed young men for this work. This assertion may appear strange, but I assure you that it is the 'lack' of experience which has created this industry. If I had paid attention to all the doubt and hesitation brought forward by the so-called authorities during the development of our enterprise, the Norwegian nitrate industry of to-day would never have existed. Thanks to the young people, to their undaunted courage, energy and love of action, the work has been done, and it is in grateful remembrance of all our struggles I, as their boss, had with the men in joy and sorrow that I look backward to the work that has been done."

* Paper read before the International Congress of Applied Chemistry. The account here given is reproduced from *Metallurgical and Chemical Engineering.*

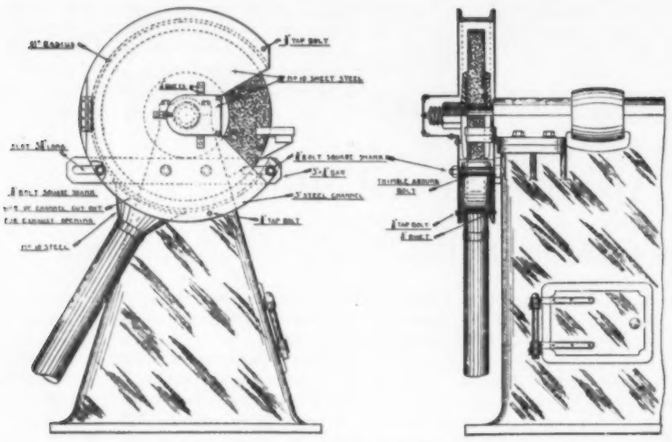


Fig. 1.—Safety Exhaust Hood for 20-inch by 2-inch Grinder.

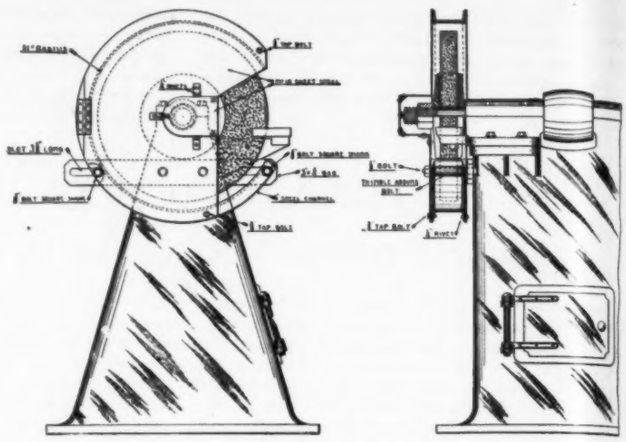


Fig. 2.—Safety Hood, Without Exhaust, for 20-inch by 2-inch Grinder.

Grinding Wheels and Safety of Operation*

Protecting Human Life and Limb

[*Industrial accidents are a source of loss to the employee, the employer, and the community at large. Quite apart from any considerations of sentiment, therefore, all classes are interested in the movement for greater safety in industrial operations. The* SCIENTIFIC AMERICAN *does its share in promoting this cause by offering annually, under the auspices of the American Museum of Safety, a medal for meritorious "devices for conserving human life and limb." In* 1912 *this medal was awarded to the Norton Company, manufacturers of grinding wheels. A facsimile of the medal appears at the end of the article here presented.*—EDITOR.]

GRINDING wheels have come to be used in large numbers and for a great variety of purposes in many industries, and they are being continually introduced as substitutes for machine tools, both for rough dressing and for the finishing of machined parts. The rapid increase in the number of accidents resulting from the operation of these wheels emphasizes the necessity for more careful inspection of all grinding apparatus used in plants that we insure—speed, equipment, and method of operation receiving particular attention.

EMERY WHEELS.

The term "emery wheels" is here used in its popular sense, and includes all wheels of this type, whether made of artificial products such as alundum, carborundum, or crystolon, or of natural abrasives like emery and corundum. The tensile strength of these wheels varies according to the size of grain and degree of hardness—the finer the grain and the harder the wheel, the greater the strength. Wheel hardness depends on the kind of bond employed to cement together the emery grains, and also upon its heat treatment and other factors. Vitrified wheels, in which the bond is fused in kilns where a temperature of about 3,000 deg. Fahr. is attained, are the ones most commonly used for ordinary purposes. Silicate wheels, made by a tamping process without burning, are used to some extent in the large sizes. Elastic wheels, with a bond of elastic composition, are used principally where thin wheels are required, as for saw gumming. In view of the fact that twenty sizes of abrasive grain and twenty-six degrees of hardness are employed in various combinations in the commercial product, it is obviously impracticable to treat each grade separately. The speed limits given are accordingly intended to meet average conditions.

A careful consideration of the subject shows that guards in the form of hoods are essential to the proper equipment of grinders, not only to prevent the flying of broken parts in case of rupture, but also to protect the eyes of the operator from dust. The importance of such hoods is now recognized, and leading manufacturers recommend their use wherever possible. We are aware that many employers and foremen object to providing hoods and offer various excuses, the most common being that they interfere with the work, and that grinding is done on all portions of the wheel. In most cases the difficulties are greatly exaggerated or purely imaginary, and employers can usually be convinced that the output will not be lessened by the use of suitable guards. For some kinds of work it may be impracticable to use hoods, and in such cases it is proper to recommend safety flanges. It should be noted, however, that the use of safety flanges does not afford complete protection, and they should not be recommended as a substitute for hoods except where hoods cannot be used. The most common causes of wheel breakage are accidental blows, and the fouling of work between the tool rest and the wheel. Flanges, in such cases, will not hold the outside portion of the rim, nor will they prevent the dust from flying in all direction.

To safeguard the health of the operators, exhaust fans should be connected to the protection hoods. While we cannot insist on an equipment of this kind, except where it is required by State laws, we strongly recommend it. When dust is not suitably removed by exhaust fans, goggles should be provided for the men.

The conditions to be satisfied for the safe operation of grinding wheels are outlined below:

Stands.—Grinding machines should be sufficiently heavy and rigid to prevent vibration, and they should be securely mounted on substantial foundations. Heavy wheels on light stands are a source of danger, and they never do satisfactory work.

Bearings.—Boxes must be of proper length to provide an ample bearing surface, and prevent heating or rapid wear. It is important that the bearings be kept well lubricated and properly adjusted. Ring oiling devices are recommended, and box caps should be adjustable for take-up.

Spindles.—Spindles must be of proper size to prevent springing by the pressure of the work. Standard sizes, for comparison, for wheels up to 2½ inches in thickness, are given below in inches:

Diameter of wheel.....	6	9	12	15	18	21	24
Diameter of spindle between flanges.....	½	¾	1	1¼	1½	1¾	2

Belt Drive.—The spindle should carry only one pulley. The use of cone pulleys, which allow of two or more speeds, makes it possible to over-speed new wheels. When wheels wear down so that the rim velocity is too low for efficient cutting, they should be removed to other spindles that are suitably speeded.

The ideal arrangement for a belt drive is to have the shafting and motors located in the basement, underneath the main floor. The annoyance and danger of overhead

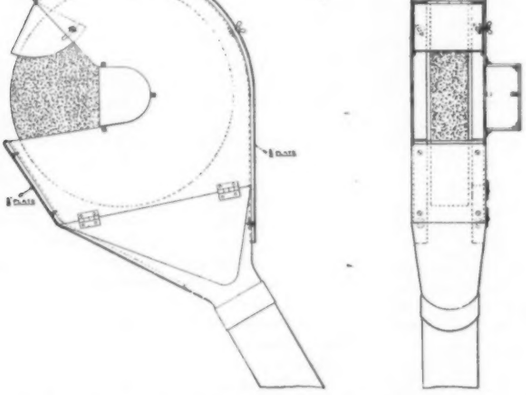


Fig. 3.—Safety Exhaust Hood for Grinder Wheels

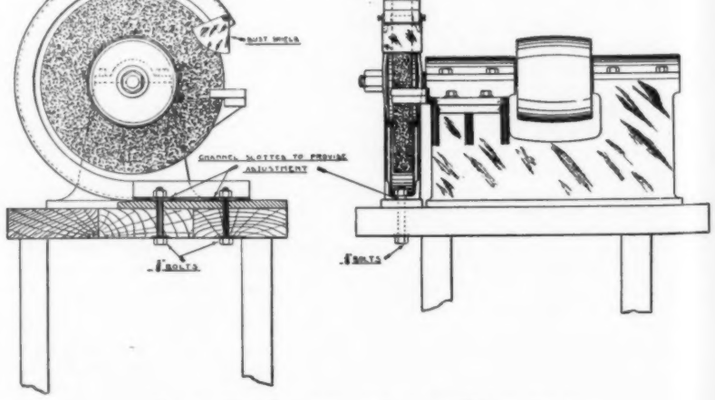


Fig. 4.—Ring Guard for 14-inch by 1½-inch Grinder.

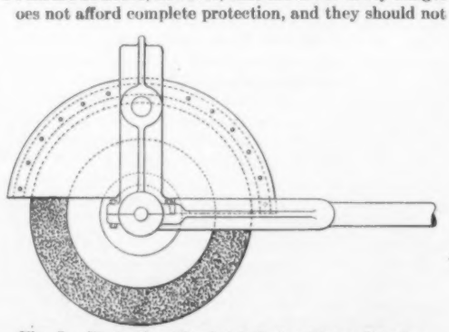


Fig. 5.—Protecting Hood for Swing-frame Grinder.

* Copyright 1912 by the Travelers' Insurance Company, Hartford, Conn.

belting and shafting are in this way overcome, and by placing a shield over the spindle pulley, the danger resulting from a breaking belt is eliminated.

The best design for grinding machines, both from economic and from safety view-points, consists of individual motor drive, with the motor armature mounted directly on the spindle. This is being more and more adopted in up-to-date plants.

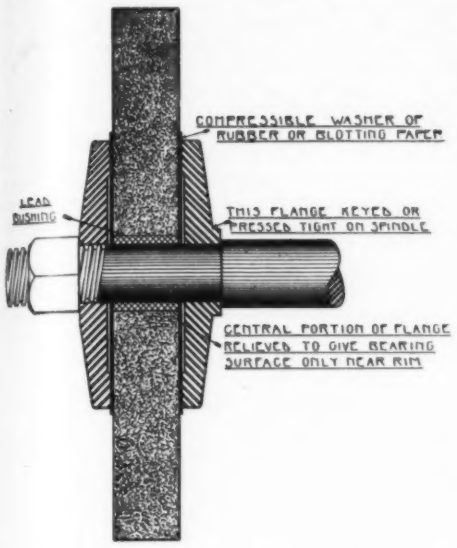

COMPRESSIBLE WASHER OF RUBBER OR BLOTTING PAPER
LEAD BUSHING
THIS FLANGE KEYED OR PRESSED TIGHT ON SPINDLE
CENTRAL PORTION OF FLANGE RELIEVED TO GIVE BEARING SURFACE ONLY NEAR RIM

Fig. 6.—Correct Mounting for Grinding Wheel.

Flanges.—The diameter of the flanges should not be less than one half the diameter of the wheel. In some special cases flanges of greater diameter can be used to advantage. The flanges should be relieved or recessed toward the center, so that the bearing surfaces in contact with the wheel will be annular or ring-shaped, and close to the circumference of the flanges, as indicated in Figs. No. 6 and No. 7. The inside flange should be keyed or pressed on the spindle, to prevent the crawling of the nut due to the drag of the box on the flange.

Washers.—Washers of compressible material, slightly larger than the flanges, should always be used on both sides, between the flanges and the wheel, to distribute the pressure over surface inequalities. They are commonly made of blotting paper or rubber gasket.

Fitting of Wheels.—Wheels must be an easy fit on their spindles. They should never be forced on, nor should they be loose. If forced on, cracks are likely to be started—if loose on the spindle, the wheel will be off center.

Inspection of Wheels.—Wheels should be carefully examined and tapped lightly with a small hammer, before mounting. Rough handling in transit may result in the development of hidden cracks which will not be disclosed by casual observation. Numerous cases are on record where new wheels have burst when first brought up to speed, before being used. Too much reliance should not be placed upon the fact that wheels are tested at the factory before shipping.

Tightening Nut.—The nut should be screwed up only moderately tight, unnecessary pressure against the wheel being avoided.

Tool Rest.—The tool rest must be rigid, and must be kept adjusted close to the wheel, to prevent the work from being caught. Carelessness in this respect is responsible for many accidents—probably for more than any other single cause.

Speed.—For practical purposes a maximum rim velocity of 5,000 feet per minute may be taken as a safe limit for plain wheels mounted on bench and floor stands.

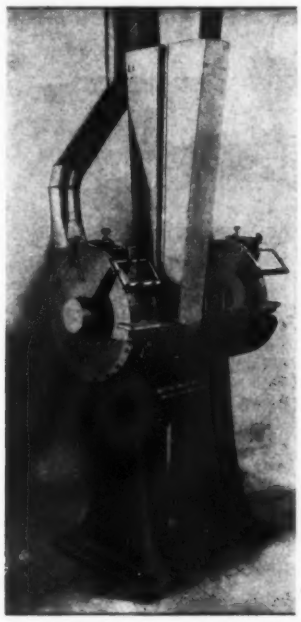


Fig. 8.—Exhaust Hoods and Dust Shields.

Cup wheels, cylinders, and special shapes, should not run faster than 4,000 feet per minute. This latter limit also applies to all wheels running wet.

When mounted on universal grinders, cylindrical grinders, or similar machines of high grade construction, a rim velocity of 6,000 feet per minute is allowable for solid disk wheels.

The rim stress per square inch is approximately 48 pounds at 4,000 feet per minute, 75 pounds at 5,000 feet per minute, and 108 pounds at 6,000 feet per minute, increasing in proportion to the square of the velocity of rotation.

Truth and Balance.—Wheels should be kept true and in perfect balance, and for this purpose it is important that proper tools be used for both dressing and truing. Hacking and gouging with improvised tools is a dangerous practice. The term "dressing" is used to indicate a sharpening operation with corrugated tools, and should not be confused with "truing."

Hoods.—Safety hoods should be provided for all wheels, except in special cases where the nature of the operation absolutely prevents their use. It is advisable to connect the hoods with an exhaust fan for the removal of dust. (This is required by statute in some States). The hoods should also be made to cover the threaded end of the spindle, so that the operator's clothing may not be caught and wound up. The designs shown in Figs. Nos. 1, 2, 3 and 5 illustrate a variety of hood guards. The hoods in every case should be adapted to the conditions, the particular design being immaterial so long as the desired result is accomplished. The ring guard shown in plate No. 4 does not afford complete protection, but it answers reasonably well for small bench grinders where it is impossible to secure the installation of complete guards. Where exhaust hoods of light sheet metal have already been applied, these may be reinforced by heavy plates to withstand the shock of a bursting wheel. When a hood cannot be used, safety flanges should be adopted, or straight flanges having a diameter not less than three fourths of the wheel diameter should be provided.

SCIENTIFIC AMERICAN Medal for Devices for Conserving Human Life and Limb.

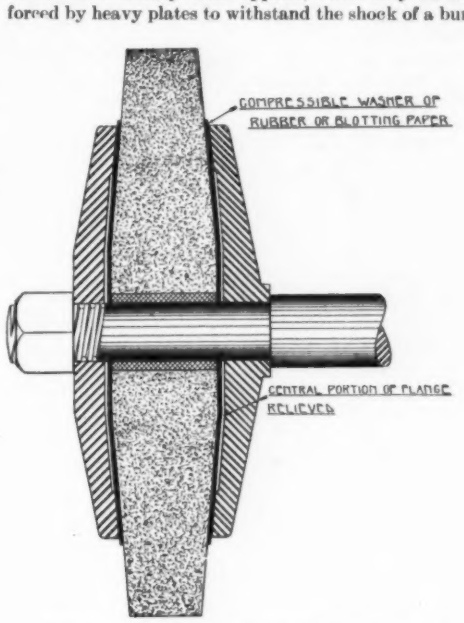


Fig. 7.—Safety Flanges for Grinding Wheels.

A well protected twin grinding stand, equipped with belt guards, dust shields, and hoods with exhaust connection, is shown in plate No. 8.

Goggles.—In grinding rooms and other places where dust is not disposed of, goggles should be provided. The goggles should be of substantial construction, with heavy eye glass. A number of different makes have recently been brought into the market.

Causes of Accidents.—The commonest causes of wheel breakage are:

Fouling of work between the rest and the wheel.

Improper mounting.

Overspeed.

Heating of the spindle, and resulting expansion, when bearings run hot.

Excessive pressure of work against the wheel, and the consequent heating of the rim.

Allowing spindles to become loose in the boxes through wear.

Allowing wheels to get out of true.

Rupture may occur from many other less prominent causes, which include carelessness in various forms.

When a number of grinders are operated at the same plant, one man should be made responsible for the oiling,

GRINDSTONES

TABLE GIVING REVOLUTIONS PER MINUTE, CORRESPONDING TO CERTAIN RIM VELOCITIES IN FEET PER MINUTE.

DIAMETER OF STONE	RIM VELOCITY, IN FEET PER MINUTE		
	2500 (Limit for unknown stones)	3000 (Ultimate limit for Ohio stones)	3500 (Ultimate limit for Huron stones)
2′-0″	398	477	557
2′-6″	318	382	446
3′-0″	265	318	371
3′-6″	227	273	318
4′-0″	199	239	279
4′-6″	177	212	248
5′-0″	159	191	223
5′-6″	145	174	203
6′-0″	133	159	186
6′-6″	122	147	171
7′-0″	114	136	159
7′-6″	106	127	149
8′-0″	99	119	139

EMERY WHEELS

TABLE GIVING REVOLUTIONS PER MINUTE, CORRESPONDING TO CERTAIN RIM VELOCITIES IN FEET PER MINUTE.

Diam. of wheel in inches	RIM VELOCITY, IN FEET PER MINUTE				
	4000 (Limit for cups, cylinders, and wet wheels)	4500	5000 (Limit for solid wheels on ordinary stands)	5500	6000 (Limit for solid wheels on grinding machines)
4″	3820	4297	4775	5252	5730
5″	3056	3438	3820	4202	4584
6″	2546	2865	3183	3501	3820
7″	2183	2456	2728	3001	3274
8″	1910	2149	2387	2626	2865
10″	1528	1719	1910	2101	2292
12″	1273	1432	1592	1751	1910
14″	1091	1228	1364	1501	1637
16″	955	1074	1194	1313	1432
18″	849	955	1061	1167	1273
20″	764	859	955	1050	1146
22″	694	781	868	955	1042
24″	637	716	796	875	955
26″	588	661	735	808	881
28″	546	614	682	750	819
30″	509	573	637	700	764
36″	424	477	531	584	637
42″	364	409	455	500	546
48″	318	358	398	438	477
54″	283	318	354	389	424
60″	255	286	318	350	382

the speed, the care of belts and machines, and the general maintenance of the equipment.

Grindstones.—Although they burst less frequently, grindstones are a source of danger as well as emery wheels, especially when improperly mounted or when run at excessive speed.

Probably more grindstone failures have resulted from faulty methods of mounting than from overspeed. The use of wooden wedges has been the principal source of trouble in this respect, these being driven excessively tight, or becoming wet and swelling after being driven, so that cracks have been started in the corners of the square holes, and these cracks, radiating outward, have so weakened the stones that rupture has resulted at normal speed. The holes at the centers of the stones should be round, but the practice of cutting them square will probably continue for a long time, now that it has become so firmly established. The tendency for cracks to start can be largely if not entirely overcome, however, by adopting a suitable method of mounting.

Proper Mounting.—Flanges of generous proportions should be used to support the stone and connect it rigidly with the arbor. After the stone is centered, it is a good practice to fill the central space around the arbor with cement or lead. Wooden washers, ½ inch to 1 inch in thickness, are to be inserted between the flanges and the stone, and the flanges are then to be clamped in place by heavy nuts. A double thickness of leather or rubber gasket may be substituted for the wooden washers. The use of wooden wedges should not be permitted.

Safe Speed.—The safe allowable peripheral speed is somewhat variable, depending, as in the case of emery wheels, upon the grade of grit and the hardness of the stone. The nature of the stone is indicated by the locality in which it is quarried. The two best known and most widely used varieties are the Ohio and Huron grindstones, the latter being safe for somewhat higher speeds than the former, owing to their greater hardness and fineness of grain. Ohio stones should never be run with a rim velocity in excess of 3,000 feet per minute, and should ordinarily be kept under 2,500 feet per minute. Huron stones may be allowed 3,500 feet per minute, but it is better to limit them to 3,000 feet per minute, maximum. Unknown varieties of stone should be limited to 2,500 feet per minute.

Polishing Wheels.—Polishing or buffing wheels having wood centers or iron centers, or of muslin, felt, or sea horse construction, are run at peripheral speeds of from 3,000 to 7,000 feet per minute. It is rarely necessary to exceed 6,000 feet per minute, and for most purposes 4,000 feet per minute is sufficient. When kept in good condition and in perfect balance, and when suitably mounted on substantial buffing lathes, they are safe for speeds between the limits given. Exhaust hoods should be provided.

Use of the Tables.—Tables are given on page 333, for finding the number of revolutions per minute that an emery wheel or grindstone is making, when the rim velocity is known; and these tables can also be readily used for the converse operation; namely, for finding the rim velocity of the wheel, when the number of revolutions per minute is known.

By way of illustration, suppose an emery wheel that is 12 inches in diameter is to run at a rim speed of 5,500 feet per minute, and that we wish to know how many revolutions per minute it will be making when it has this given rim velocity. We find 12 inches (the diameter of the wheel) in the first column of the table, and we look along the horizontal line opposite this diameter until we come to the column headed 5,500, and there we find 1,751, which is the number of revolutions per minute that the 12-inch wheel will be making, when its rim velocity is 5,500 feet per minute.

As a second illustration, let us suppose that a grindstone, 5 feet 6 inches in diameter, is making 200 revolutions per minute, and that we wish to know its rim velocity. Passing to the table for grindstones, we first find the diameter of the stone (5 feet 6 inches) in the first column, and we look along the horizontal line opposite to this number, and try to find 200 (the number of revolutions per minute). We do not find 200, but we do find 203, and by looking at the heading at the top of the table, above this number, we see that at 203 revolutions per minute the given grindstone would have a rim velocity of 3,500 feet per minute. Hence we conclude that the rim velocity of the stone at 200 revolutions per minute would be a little less than 3,500 feet per minute. The exact figure, in point of fact, is 3,450.

This information will usually be sufficient for the inspector, as his main object in using the table is to ascertain whether or not the rim velocity is within the limit that experience has indicated to be safe for the kind of stone with which he is dealing.

Non-stop Delivery to Aeroplanes*

A Proposed Device for Taking On Board Supplies While in Full Flight

We illustrate a device by which it is proposed to render feasible the delivery of supplies to aeroplanes in full flight. It is in a way analogous to the delivery of water to locomotives and letters to mail trains, without stopping.

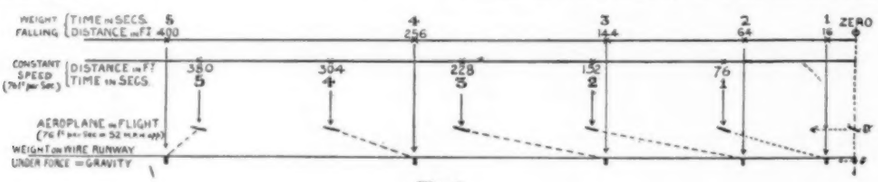

WEIGHT FALLING
TIME in SECS. 5 4 3 2 1 ZERO
DISTANCE in FT 400 256 144 64 16
CONSTANT SPEED (76 Ft per Sec)
DISTANCE in FT 380 304 228 152 76
TIME in SECS 5 4 3 2 1
AEROPLANE in FLIGHT
WEIGHT on WIRE RUNWAY UNDER FORCE = GRAVITY

Fig. 1.

By the means described it is proposed to facilitate the supply of despatches, small arm ammunition, gasoline, medical stores, and such like in war time, or postal matter in peace time. The idea is to save the time needed for alighting and avoid the risk of injuries through landing in positions where the ground is unsuitable. In war especially rugged positions are often of special importance, and landing in the vicinity almost impossible; at the same time the supply of small arm ammunition, medical stores, or water may be of extreme value, and time of vital importance. The delivery into netting is not shown in this issue, which deals only with the supply to the aeroplane itself.

It is, of course, easily calculated that (friction disregarded) an object falling from a height of 90 feet would attain a speed equal to 76 feet per second (the assumed speed of the aeroplane), and the time required would be under 2½ seconds. In other words, the application of a *horizontal* force of 100 pounds would, in 2½ seconds, give a free running load of 100 pounds weight a velocity of 76 feet per second.

1. The first diagram illustrates this, and shows the relative positions of load and aeroplane at various periods after engagement has taken place.

2. The second diagram shows a typical supply station consisting of a wire rope-way of about 400 feet span, upon which the load to be lifted is free to run.

3. The third diagram shows in greater detail the starting point. It will be seen that a wire loop from the load is stretched open between two poles by light lashings, which break away when the grapnel hanging down from the aeroplane engages with the bight of the wire rope. When the lifting rope on the grapnel and the wire loop from the load are pulled taut, shock is avoided by the peculiar arrangement of gear on the machine.

4. In Fig. 4 is shown a biplane equipped with a winding drum and grapnel, the lifting line in its pre-engagement position passing over a pulley on a spring-controlled arm to ease the first stress of making contact.

5. A section of the drum and appurtenances is shown in Fig. 5. It consists essentially of a drum with a friction disk on the center line of its periphery, which, when in action, is in contact with a similar disk on an engine-driven shaft. The amount of transmitted torque is determined by an adjusted spring, as shown. By rotating the de-clutching handle the drum is moved away from the driving disk and ceases to be power-

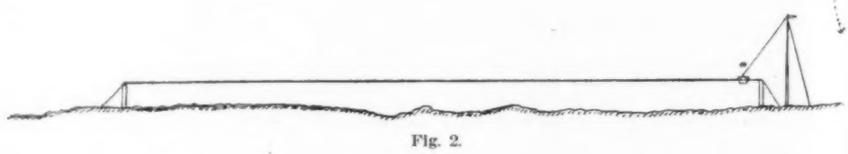


Fig. 2.

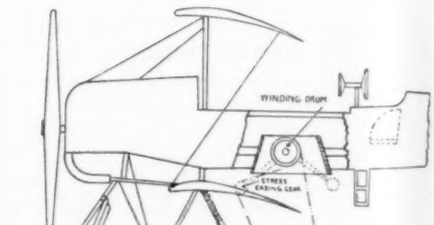


Fig. 4.

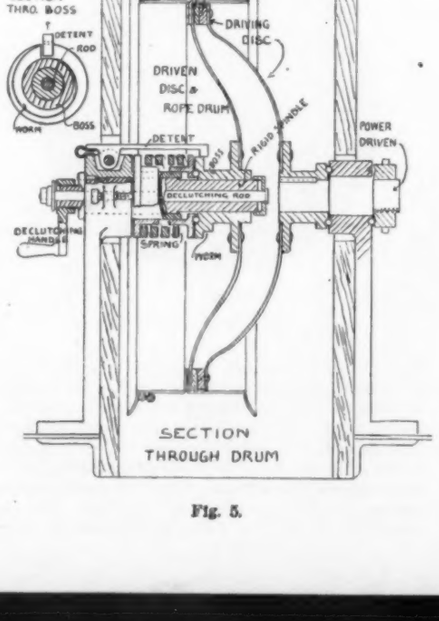


Fig. 5.

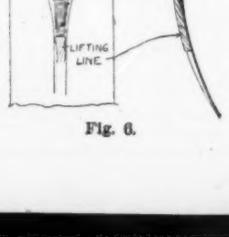


Fig. 6.

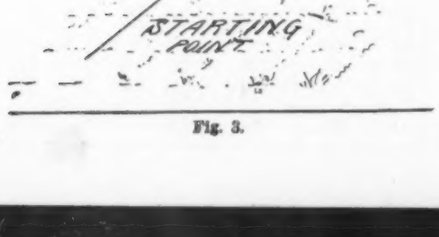


Fig. 3.

* Reproduced from *Aeronautics*.

driven. It is automatically held out of contact by the detent and the de-clutching rod may then be restored to its original position.

The lifting line is attached to the drum in such a manner (see Figs. 5 and 6) that if the grapnel engaged accidentally in an immovable object or attempt was made to lift anything over the pre-arranged load it would cause all the cable to come off the drum and be pulled clear without risk to the aeroplane, a fresh line and grapnel would, however, have to be rigged.

Security is thus assured against disaster. Now let us assume that the load to be handled is 100 pounds, and the frictional contact set to release at, say, 150 pounds.

When the grapnel has "engaged" and the lines are

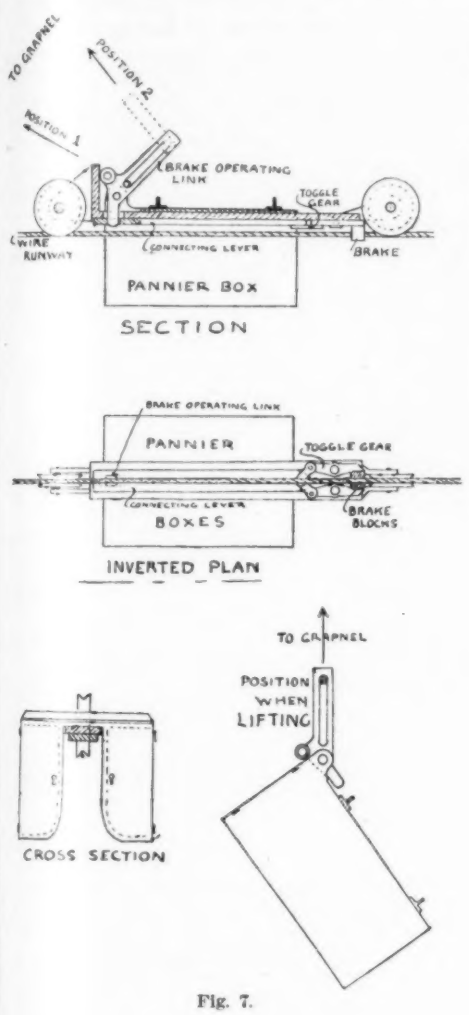


Fig. 7.

taut, the drum is still held out of action from the driving disk. The rope carried may be, say, 120 feet in length, its weight 3½ pounds, its breaking strain 1,000 pounds, and, although the drum is quite free to revolve, its inertia would still cause a jar. The pull, therefore, first affects the easing device; the resistance offered here causes 100 pounds rotational effect on the drum periphery, starting it into motion. As it revolves it gradually raises the detent by the cam path or worm cut on the boss and releases itself, whereby the spring pushes it into frictional contact with the driving disk; but the comparative immobility of the load in response to the pull of 100 pounds causes it to continue to *unwind* the lifting rope. In about three seconds, however, the load has traveled 144 feet, the aeroplane having traveled 228 feet, so that 84 feet of line has been pulled off the drum.

If the drum be 3 feet in circumference, this would be 28 turns, but, as the load has at this point a velocity of 96 feet per second, the drum must now be *inwinding* as the speed is in excess of that of the aeroplane.

The acceleration of the load, however, continues, and would cause trouble by under-running the aeroplane and, swinging forward, drag the cable off the drum again. But this tendency is checked, as will be seen by examining Fig. 7, wherein is shown the attachment of the wire loop on to the load by the medium of a special link. When the angularity of pull assumes a given angle the shackle runs up the slot in the link and sets a brake in action through toggle levers. This brake causes retardation until (by alteration of angularity and pull) the shackle runs down the link again. Finally the load runs off the wire-way and is lifted as it swings free.

In Fig. 8 is illustrated the grapnel, which for clearness is shown with only two prongs; it would have four

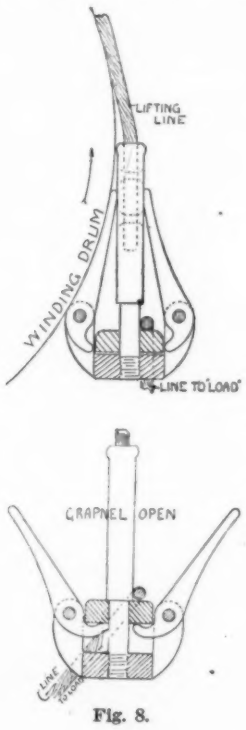


Fig. 8.

in practice. It will be noticed that its prongs close and thereby admit of passage over the drum, thus allowing the load to be raised right up to the drum.

In Fig. 9 is shown the picking up of despatches from the side of a ship by a machine with this equipment; the water constitutes the equivalent of the wire runway and both ship and aeroplane may be at full speed.

It is interesting to note the retarding effect on the aeroplane due to setting the load on the land equipment in motion.

It is as follows:

Assume weight to be 1,500 pounds and speed 76 feet per second; the kinetic energy will be

$$\frac{1{,}500 \times 76 \times 76}{2 \times 32.2} = 134{,}534 \text{ feet pounds.}$$

If the retardation lasted for 4½ seconds, or over a distance of 342 feet, there would be a loss of 34,000 foot pounds, lowering the speed to 66 feet per second, or 45 miles per hour. This assumes, of course, that the machine has no reserve of power. In actual use the ground equipment would probably be set up *against* the wind. The essence of the invention lies in the fact that the power of the aeroplane is first used to give a motion of translation before lifting is effected, and that this is achieved without calling into action a stress materially greater than that involved in the lifting of the load.

The *raison d'être* for this equipment is thus set forth by the inventor, Mr. Scott Snell.

"The aeroplane for scouting purposes is an established necessity; in a limited degree it is also useful for dropping explosives. But an immense forward step in its effectiveness is reached when it can *without stopping* pick up ammunition or projectiles of 100 pounds weight, or take up without stopping a supply of fuel, giving it 100 miles further radius of action. Assuming the power exists to do this, we have some very important developments in its utility in warfare. Bursting charges comparable only to those used in heavy siege guns can be employed upon a city or encampment, or troops, under conditions not previously existing. *Heavy guns* adaptable to such charges cannot be transported very rapidly and must be effectively protected from attack; in fact, are part and parcel of a *main army*.

"Compare their usefulness to the following tactics of, say, three aeroplanes. From a point 25 miles away from an enemy's position a few well-horsed ammunition wagons are assembled. In ten minutes the ground equipment is set up. When all is ready an aeroplane sweeps past the equipment, and *without a pause* passes on with 100 pounds of explosive attached. In about half an hour this can be dropped in the enemy's position. A second machine follows the first in fifteen minutes, and the third at a similar interval, so that the first machine is back to take up its load in regular sequence of time.

"We get every quarter of an hour a bursting charge of approximately 100 pounds of high explosive dropped over the enemy's position. His only relief is to drive off the attacking party, but:

"1. This position can be kept unknown, as machines need not approach the enemy directly from the same way.

"2. Any movement for counter-attack by troops below is under continuous observation from the aeroplanes in carrying out their duty.

"3. No surprise attack can therefore take place.

"4. When such attack does mature, in retiring no heavy gun has to be moved, and the position can be *vacated in fifteen minutes.*

"5. If all the ground equipment had to be abandoned, the loss of material would be insignificant, less than $250.

"In effect we have 'flying guns,' for such the aeroplane would become, though capable of firing only very slowly. But it has an unlimited range, and can insure *effective application* of its explosive. It cannot be overtaken by any ground force, and there is no need of a powerful infantry support, or of a strenuous defence of its base, so essential where heavy guns are in use. In short, the aeroplane for destructive purposes now takes a very forceful position, so much so that it is foolish to disregard its potentialities.

"Take the attack upon such a fortress as Port Arthur, and contrast the old form of bombardment by heavy guns placed in positions which have only been won after bloody struggles. The erstwhile 'keys' to the position have now disappeared; the present method of defence by fixed gun positions becomes very nearly useless.

"The same system of land feeding of aeroplanes with war material also enables ships to feed aeroplanes, and a few fast vessels properly equipped would seriously menace any port in the world.

"The land equipment is of such a nature that it can be used on rough surfaces, in fact, it renders the aeroplane independent of the character of the ground. It can be set out or rearranged, to suit the direction of the wind, so that the aeroplane can make the course most suitable for picking up its load, preferably directly against, or before, the wind.

"As the flight of the aeroplane may be such as to approach the position to be attacked from any direction best calculated to deceive an enemy and the ammunition supplying position may be twenty-five miles away, it would necessitate the enemy examining an area comprised in a circle of fifty miles diameter, in order to locate the depôt.

"Although the example given assumes a single ammunition depôt, the aeroplanes might be fed from several such stations, so that a steady to and fro course is

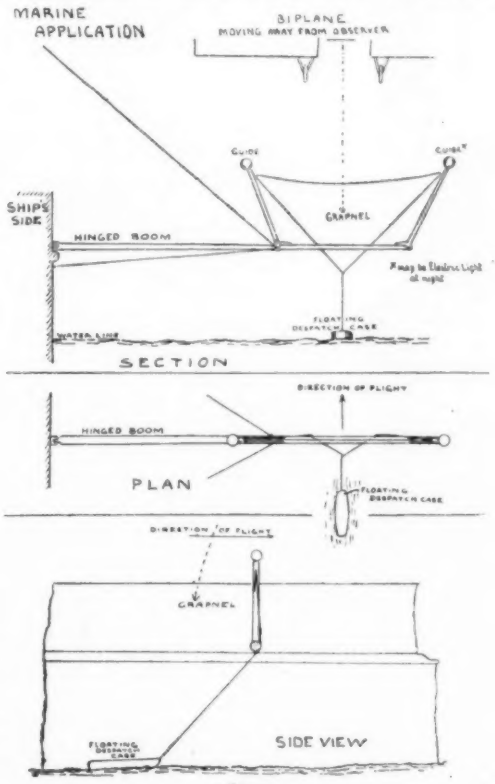


Fig. 9.

maintained over the position to be assailed. This would speed up the discharge of projectiles.

"Another application of the equipment lies in the distribution of ammunition, from a base quite out of danger, to the rear of the firing line (or within easy reach of the same), and this, too, without regard to the character of the intervening country and by a line as direct as the crow flies. Medical stores or food could also be conveyed. In mountainous countries such a direct method of quick replenishment is especially valuable and would enable positions, once gained, to be held when otherwise they might have to be abandoned. In short, the facility with which materials can be han-

dled *on any ground* by reason of the absence of the necessity for landing on the earth much enhances the value of the aeroplane as a military arm.

"Another word on the application of this invention to marine warfare. It is with to-day we have to deal and the time has not yet arrived when wireless telegraphy admits of perfect and complete intercommunication between ship and flying scout. Indeed, it seems to be assumed that the hydro-aeroplane will have to alight on the water near the ship and communicate by megaphone or utilize personal transfer by means of a boat. The latter in a choppy sea way is not an agreeable operation and, if we follow the dictum of that gallant sailor, Troubridge, and 'let the weakest fend off,' it will be bad for the hydro-aeroplane.

"Gasoline and food anyhow cannot be supplied by wireless in spite of its 'marvellous developments,' so that on the score of utility in shipping stores and thereby lengthening the period of flight, the equipment has valuable functions. The growing increase in the capacity of the aeroplane to carry weight will mean an extension of its useful functions, and whatever weight it may ultimately carry can be taken up (if necessary in sections) without a stop, on the principle herein described, since the machine is never subject to materially greater stress in engaging with the weight than is experienced in the mere lifting of it. In due time it will be easy to take up a man without stopping and without any objectionable shock, but no doubt many events will have happened before this has come about, and its utility is not at the moment obvious."

The Renovation of Daguerreotypes

PROBABLY no photographic process is so completely dead at the present time as the ingenious and beautiful method worked out by Daguerre. The present generation of photographers includes within its ranks comparatively few who are acquainted with the daguerreotype process as the result of practical manipulation, and, of course, the process at the present day possesses no conceivable applications in ordinary portrait photography. Nevertheless, some knowledge of daguerreotypes may be said to be necessary to the professional photographer. Daguerreotype portraits were made in enormous quantities up in about the sixties of the last century, and thus, at the present time, are by no means uncommon possessions among those who prize the portraits of their parents or grandparents. Naturally, when the possessor of such an ancient photograph perceives it to be "faded," his immediate resort is to a photographer in whose knowledge, providentially, he has faith, and by whom, so he anticipates, the specimen can be easily restored. In many cases we fear that his optimism receives a rude shock unless the photographer is astute enough to disguise the fact of his own ignorance of the practical methods to be employed. Too often, we fear, a photographer is incapable of distinguishing between a genuine daguerreotype and an equally common, or even more common, form of photograph, namely, the collodion transparency backed up with black velvet or a coating of black varnish. And even when there is full competence to deal with such requests, instances have come before our notice where a customer has been somewhat brusquely told that it did not pay a photographer "to undertake such a job as that"—obviously a policy which is the very best conceivable for the purpose of driving that particular customer, and many others whom he would tell of the incident, away from the studio.

As a matter of fact, the restoration of a daguerreotype calls for comparatively little skill. It does call for a certain amount of practice, otherwise it is easy to injure the delicate surface of the daguerreotype plate. But if one or two old plates can be obtained, as they often can for a trifle in sales of miscellaneous property, it is quite easy to make certain of success in effecting their restoration. The practical procedure is as follows: The first thing to do, after removing the plate from its case, is to scrape off all paper from the back, taking care that none of the particles attach themselves to the front surface of the plate. The plate is then dusted by blowing upon it, or, if it cannot be cleansed of dust in this way, by rinsing it in water. It is best not to use a brush, since the daguerreotype image in some cases is very sensitive to such treatment. The plate is now flowed over several times with alcohol, using the purer industrial spirit, free from mineral naphtha. The ordinary methylated spirit of the oil-stores should be avoided, and, if the purer industrial spirit is not obtainable, spirit of wine may be used. Though much more expensive, the quantity employed is quite small. The next operation is to rinse the plate in water, and then to apply to it a solution of potassium cyanide. This removes what the customer calls "fading" of the picture. The effect, of course, is not an actual fading of the image at all, but a tarnishing of the silver coating, as a result of exposure to fumes, etc., containing traces of sulphur. Potassium cyanide is an active agent in removing this tarnish; but, it must also be remembered, does exert a considerable solvent action on the image itself. For this reason its application must be done in the most tentative manner. It is not possible to prescribe a definite strength of solution, owing to the fact that cyanide commercially is a most variable substance. The best plan is to make a fairly strong solution, and add a few drops at a time to an ounce or two of water until the solution commences to act upon the tarnish of the plate.

As soon as the picture is seen to be cleared by this process, the plate is once more well rinsed back and front under the tap, and it only now remains to dry it and replace it in its frame. The drying, however, requires to be done carefully, and, according to a certain plan, otherwise streaks or lines are liable to be produced. A tiny ring gas-burner, about two inches in diameter, forms the most convenient source of heat for drying. The plate is gripped by a pair of pliers at the left-hand-bottom corner, and allowed to drain for a minute or so, being held still during this time. The top corner is now brought gradually over the burner, and as the plate shows signs of drying, it is slowly raised so that the drying proceeds evenly downward. The point of importance is to secure a regular rate of drying, otherwise a mark or line is very liable to be formed. The plate is now laid in contact with the original cover-glass, and the two bound together by a suitable paper binding. For this purpose the most suitable adhesive is ordinary starch or flour paste, since this latter will retain its adhesive qualities, even if the specimen becomes extremely dry. Too much stress cannot be laid on the necessity of binding the specimens properly in its case. Too often it is found that those undertaking renovation will simply put the plate loosely back in the frame, with the subsequent result that the picture speedily loses its restored brilliance.—*The British Journal of Photography.*

A Method of Mimicking Amœboid Motion and Protoplasmic Streaming

By Prof. T. Brailsford Robertson

THE following method of mimicking amœboid motion and protoplasmic streaming has been employed by me for class-demonstrations during the past five years. As it is extremely simple and yields results which are very striking and instructive, it appears advisable to communicate it to a wider public.

It is well known that if particles of camphor be dropped upon the surface of clean water they display energetic movements which are attributed to large and unequally distributed alterations in the superficial tension of the air-water surface at points of contact with the camphor. It occurred to me, therefore, that if camphor could be incorporated into a fluid immiscible with water, drops of the mixture placed upon water might be expected to display surface deformations resembling those occurring in the formation of pseudopodia. This anticipation proved correct.

I prepare a 10 per cent solution of camphor gum in benzol and then, since drops of this water-white liquid are difficult to observe upon the surface of water, I color it deeply by the addition of Sudan III or Scharlach R. If a drop of this mixture be placed upon the surface of water, violent and extremely rapid deformations of surface are observed. Lengthy and irregular "pseudopodia" are rapidly thrown out and withdrawn. The whole drop exhibits a veritable ecstasy of motion which shortly ceases when a fine incrustation of precipitated camphor has spread over the water.

By successive additions of some viscous liquid such as olive oil to the mixture the motions of the drops can be rendered slower and slower and more readily followed in detail by the eye. When at length a mixture is formed of equal volumes of olive oil and the camphor-benzol solution the formation of "pseudopodia" is no longer observed; instead, we observe a prolonged and energetic streaming movement within the drop which mimics in the closest manner imaginable the phenomenon of protoplasmic streaming.

In this way the modifying influence of viscosity upon the reaction of fluid masses to local changes in superficial tension can be shown in any desired gradation; it appears probable that a superficial semi-solid pellicle must restrain the movement of the fluid in much the same way as internal friction. Hence, the phenomena of protoplasmic streaming and amœboid motion are readily traced to the same origin.—*Science.*

Natural Gas in Holland

NATURAL gas exists in various parts of Holland, says U. S. Consul F. W. Mahin of Amsterdam. In the Vondel Park, in Amsterdam, it is manifest in bubbles on the small, shallow lakes, and in similar places elsewhere, and can be lighted by a certain process, but no practical use is made of it. However, near Alkmaar, northwest of Amsterdam, the gas is abundant enough to be made useful. It appears there on polders (drained marshy land below sea level) and on two of them gas plants have been installed at farmhouses. The installation comprises a well, into which water from the soil filters, with a gas generator placed therein, this extracting the gaseous properties from the water and conducting them to a reservoir containing a supply for the house. The gas thus obtained provides all the wants for cooking, heating, and lighting in the house or any other part of the farmyard. After the plant is once installed, which is at a small expense, the cost is absolutely nothing, and the quality of the gas is said to be particularly good. It is a great convenience and an economical benefit to the farmers using it.—*American Artisan.*

Chrome-nickel Bronze

CHROME-NICKEL bronze is now being manufactured by a Philadelphia company, the product being known as "Chromax bronze." The proportions of metal in the alloy are said to be as follows: Copper, 66.66 per cent; zinc, 12.13 per cent; nickel, 15.15 per cent; chromium, 3.03 per cent; and aluminium, 3.03 per cent. The tensile strength of the alloy is said to be 79,000 pounds per square inch; the color is white, and it takes a fine, silvery polish; the fracture is fine and dense, particularly after being remelted; and the alloy, owing to its high melting point, has a denser structure and greater compressive strength than manganese bronze. It can be rolled into sheets and wire.—*Journ. Ind. and Eng. Chem.*

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